THE

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A 100-TON ELECTRIC LOCOMOTIVE.

THIS seems rather a large order, at first sight, but when we read through the article in *Engineering* describing this locomotive, the great weight of it is not at all surprising, being partly made up of an engine and boiler, a dynamo-electric generator, and a carriage and wheels to carry them; the rest of the weight consists of an electromotor coupled to an axle, so that the whole may be propelled along a railway and haul a train at 80 to 100 miles an hour.

M. Heilman, of Paris, hit on this brilliant idea, and an electric locomotive carrying its own generating plant, consisting of engine, boiler, coals and water, and generating dynamo, is actually about to be completed and run on an ordinary railway, as it requires no overhead or underground conductors, nor accumulators. One advantage claimed is that the heavy weight of this travelling generating plant can be used to produce great adhesion between the wheels and rails; we do not doubt the existence of the great adhesion. The chief advantage claimed is that a first-class high speed engine working a dynamo is a much more economical machine than a locomotive engine working direct. It is hardly necessary, we think, to express an opinion on that point, for how such a locomotive can compete with the simple steam locomotive seems incomprehensible.

We remember an attempt to carry out a similar scheme with a small boat on the Thames, which carried an engine, boiler, dynamo and motor, the motor driving the screw; the dynamo and motor in the presence of the engine and boiler were quite superfluous, and the absurdity was carried still further by the addition of a set of storage batteries.

Perhaps the most interesting results of the preliminary experiments with the locomotive are those ascertained in trials with a three-phase generator and motor. Although not stated shortly, it was found that this motor would not start with the load on unless the speed of the generator was lowered at the start, so that the slow revolutions of the motor approximated to the speed of the generator; in short, the torque is great only when synchronism is attained, at least approximately.

Obviously slowing the engine at the moment when most power is required, that is, in starting, would not be either economical or rational. In these experiments the three-phase motor proved no better than an ordinary reversed alternator would have done.

It has, for these reasons, been decided to abandon the three-phaser, and to adopt the ordinary continuous current generator and motor, a decision which we are astonished to think was not arrived at in the first instance, considering the proximity of the generator and motor. There was no transmission of the energy to a distance required, and we await with interest the further detailed description of this locomotive with continuous currents.

Continental electricians have repeatedly asserted that multiphase motors were independent of synchronism, and that the starting torque was great enough to start with a dead load, like a railway train. Actual experiments, however, seem to have settled the question, and proved the necessity for synchronism when hard work has to be performed.

PROF. PERRY'S METER.

THE cry is still they come. Patent meters are becoming as numerous as patent arc lamps were about ten years ago. The new comer is one of the motor class of meters, belonging to the same order as Ferranti's, Edison's, Teague's, and a host of other inventors. The improvements in the Perry meter lie principally in the device adopted for opposing the motion of the motor. In motor meters the inventor starts off with the supposition that the speed of the motor is perfectly proportional to the current passing, provided some constant opposing forces are applied to resist the motion. In some meters, paddle wheels in liquid are used as opposers, in another paddle wheels in air are used, in another magnetic friction between a copper conductor and a magnet is applied; all these opposers to the motion in a meter are old devices; the novelty in the various meters lies in the application of them in the different constructions of the motor meter.

In the new meter of Prof. Perry, the main current to be measured passes through a copper cup, which cuts through a powerful magnetic field produced by a shunt circuit; this field is not uniform, but resembles the field of a Mordey alternator, so that when the cup revolves under the influence of the consumer's current, alternating currents are generated in it which oppose its motion, and as this opposing force is much greater than the opposing force of friction, variations in friction are negligible, while the opposition offered by the induced currents is quite steady and unaffected by temperature or other extraneous forces. Such is the theory of Perry's improvements; it is sound theory, and the improvements are substantial so far as they go; but the type of meter to which they have been applied is one which, although it seems at first sight a simple and effective form of instrument, has many other inherent defects not at all eradicated by the improvements in the opposing devices. In the case of meters, we are pretty much in the same position as with alternating motors. An altogether satisfactory one in every respect has not yet been suggested, so that perhaps we ought to feel thankful for small mercies.

DISTRIBUTION OF ENERGY BY GAS.

A WELL-KNOWN engineer, of great experience, has communicated to an Edinburgh paper a long letter advocating the use of gas engine sub-stations for electricity supply in the city. The engineer is no other than Mr. Brown, of Rosebank Engineering Works, Edinburgh, and his letter is of interest as confirming a feeling rapidly growing in favour of gas engine sub-stations, a subject upon which we have quite recently commented.

Mr. Brown's advocacy of the scheme comes, we are afraid, a little too late to have any effect in Edinburgh; in that city the electric lighting method is now settled. Prof. A. B. W. Kennedy's plans have been adopted, and he has been appointed to carry them out, so that unless Mr. Brown can convert the Professor to his way of thinking, Edinburgh will in all likelihood commence its lighting by electricity with a steam plant of that kind recommended by Prof. Kennedy elsewhere.

While on this subject, we may say that it would be very interesting to hear from any practical engineer, with the necessary experience, as to what has been the result in the way of maintenance and repairs required by the high-speed engines after the first two or three years' running. We have had numerous reports of tests made by the makers, and by engineers who had tests to make on the engines when new, but we do not remember having heard of any reports from engineers who have had opportunities of observing their behaviour over any lengthened period of time.

We have recently heard other experienced engineers express the same opinion as Mr. Brown, viz., that the gas engine in a few years will, to a large extent, supplant the steam engine.

The Phonopore.

THE Phonopore Company in recent circulars draw attention to the advantages of their "block connectors" for establishing telephonic communication between signal boxes, the cost being stated to be much less than the erection of a wire for any ordinary telephone system. There seems no reason to doubt that an arrangement of the kind should give satisfactory results, for the conditions are peculiarly favourable for good working. The block lines, unlike telegraph circuits, have occasional signals only sent through them, which would not, practically, interfere with speaking, and the self-induction of the magnets of the block instruments is high, so that the circuit on either side of the points where telephonic apparatus would be connected is practically "plugged," and thus very little of the telephonic effect would be shunted off. It may be questioned, however, whether two ordinary resistances or two condensers, would not enable the telephonic communication to be perfectly established without any special "block connectors." As regards the Phonopore telegraph, the inventors appear to be pegging away, but with what success is not clearly apparent. The whole point seems to be whether the apparatus has sufficient margin of adjustment for practical working. An exhibit of the system in working order, in a laboratory, goes for very little, a lengthened trial on an actual line under all conditions of weather is what must determine the value of the apparatus; if such working can be shown to be thoroughly practicable, the use of the apparatus, which possesses many points of great ingenuity, will be assured.

New Rules for Electric Wiring in the United States.

IT is interesting to note that at last some unanimity of opinion has been arrived at in the States as to the rules and regulations for the wiring of buildings to be supplied with light and power. It is to be devoutly hoped that insurance companies in England will see the necessity in their own interests of coming to some similar conclusion. The unfortunate contractor, if conscientious, has to satisfy (1) the consulting engineer, (2) the fire insurance inspector, (3) the architect, (4) the supply company's engineer. As nearly every consulting engineer, inspector, architect and company's engineer has his own peculiar interpretation of "safety" in electric wiring, the contractor, where possible, does the work in his own way and leaves the four authorities above alluded to to fight out

among themselves as to whether the installation is "safe" or not. The company's requirements being for obvious reasons the least arbitrary, the current is supplied, the client is satisfied, the contractor gets paid and retires from the scene of action. But is it not possible that our insurance companies may be living in a fool's paradise? Electric light has not been long in general use and time enough has not elapsed to show up practically the many disadvantages of wiring at 15s. per light. No one connected with electric light matters can fail to have had experience of the enormous amount of jerry wiring that is being done now, notably in ship lighting. Is it in the nature of things that there will be no day of reckoning somewhere in the future?

Safety or Danger.

THE relative safety or danger of electric light currents for medical purposes is an important matter. The letter we published a few weeks ago from Dr. Waite appears to have been communicated to the New York *Electrical World* also. We thus have an opportunity of hearing the views of experts on both sides of the herring pond. It seems to us that where light wires are well laid and *properly insulated*, any danger from the use of currents carried by them is decidedly remote; but be the chances of danger ever so small the patient should be guarded by special means of control interposed between him and the supply from the leads. There is one curious feature in the correspondence that has so far appeared in either country, and that is the absence of any reference to risk from having too little resistance in circuit with the patient. This is the kind of difficulty which many medical men, having little knowledge of electricity, may at any time have suddenly to face. The wiring and the fuse of ordinary single light leads will easily carry at least an ampère of current, and though the body has many thousand ohms resistance when dry and in health, yet when moistened this resistance is greatly reduced and, in some forms of disease, may assume so small a value that a fatal current would be sure to pass with the usual pressure on the mains. To show that this warning is not altogether needless we quote from an article which appeared in the *Electrical World* of May 27th. The author, Dr. W. M. Hutchinson, says: "Here in Brooklyn we are certainly safe at all events, as the low tension wires are all underground, except the returns of the trolley currents, which are only operated at 500 volts and are not, therefore, fatal." Does the good doctor mean by this that he is willing to submit any of his patients when under treatment to a trolley current operated at 500 volts? Surely not, for he must know as well as we do that though it may be permitted to talk in a general way of 500 volts as safe, when the high resistance of dry skin and accidental small contacts are concerned, yet with the special conditions of treatment (moistened skin and often large contacts), the resistance becomes so low that 500 volts would pass current enough for electrocution swift and sure. Whatever may be the risk from outside sources, there can hardly be a doubt that be it great or small (we believe it to be the latter), some special form of protection and control ought to be adopted within the building so that the worst thing that can happen from any outside accident is the sudden cessation of current. That this can be done satisfactorily is clear from the letters of our correspondents Messrs. Lawrence and Kirk, whose controller deserves careful attention in this controversy. They, however, seem to be unaware that magnetic cut-outs for alternating circuits have been made and, we believe, found reliable. One point at least is emphasised by this controversy, viz., that if it be true that people ignorant of electricity and its actions upon the body should not play with medical batteries, it is still more true that they should not play with "current from the main."

The Diffusion of Light.

THIS somewhat abstruse subject deserves more investigation than is bestowed upon it, for it has a most important bearing upon the practice of illumination, particularly the illumination of rooms which are naturally bounded by and contain reflecting surfaces which very considerably affect the operation of any source of light. It has been shown, for example, that as much as two-thirds of the total illumination in a room is due to reflection from the walls. The subject is one that calls for an application of that abstract science or research of which Dr. Wm. Anderson discoursed so elegantly a week or two ago, when giving the first "James Forrest" lecture at the Institution of Civil Engineers, for in scarcely any branch could we reasonably expect so much of direct practical good to follow a theoretical investigation. Whilst differences of opinion exist as to the validity of the cosine law of diffusion, scientists ought not to neglect to essay the discovery of the true principle. A step in the right direction has been taken by Dr. W. E. Sumpner whose paper on the diffusion of light has recently been published in the *Proceedings* of the Physical Society of London. Little information appears to have been recorded about the diffusive power of unpolished surfaces. The subject has certainly been studied by optical measurements by Zöllner and others, but chiefly for astronomical purposes; and the radiation from such surfaces has also been investigated with apparatus designed for measuring radiant heat. But the influence of such diffusion in increasing the illumination of rooms and open spaces, although recognised, does not appear to be appreciated to the extent that its importance deserves. Dr. Sumpner's present contribution consists in a few numerical determinations of the coefficients of reflexion, absorption and transmission of diffusing surfaces; and it is to be hoped that this important subject will attract still further investigation.

Pushing Business.

THE attractiveness of free wiring as an inducement to the public to take and pay for a supply of electricity has more to recommend it to an American mind than to the hardheaded man of business in this country. The scrutiny of the fire insurance inspector would probably have killed any such idea had it been tried by a supply company in this country. The idea of getting something for nothing did not appeal at all strongly as a rational argument to the majority of people who could afford electric lighting. Nowadays, the cheapening of electricity supply has widened the field of its application, but at the time when "free wiring" was possible only the wealthy few could indulge themselves in this way. The general experience of business life has imbued the average man with the idea that "something for nothing" is too good to be true, and that those who offer such an allurement are, in common parlance, trying to *have* him. Still, there is an easy and a difficult way of encompassing most objects, and it does not appear unlikely that a system of internal wiring on the lines of that of Cook, Smythe, and Payne, could not be treated as one of the goods and chattels of the tenant rather than, as is usually the case, the electric light wiring being a fixture and therefore belonging to the landlord and affording a striking example of the "unearned increment." Another bugbear to the consumer is lamp replacement. We have seen good results attend the adoption of a rental lamp system by the supply company. They "guaranteed" the lamps after first purchase for the payment of 1d. (one penny) a unit taken on the quarterly bills. This for 12 C.P. lamps, costing 3s. 9d. each retail, allows them a useful life of 900 hours, which is just about right. As a matter of fact, the 1d. unit left a most desirable balance in the hands of the projectors of the scheme so that its success was assured.

ARC LIGHTING.

BY E. TREMLETT CARTER.

(*Continued from page* 679.)

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III.

IF the same economical current density is adopted for all the feeders, both long and short, as it undoubtedly should be, there will be a greater drop on the longer feeders. Since it would not be permissible to allow this greater drop to reduce the feeding end voltage below the fixed limit, it must be compensated by a greater rise of voltage at the generator end. Only where the station arrangements are such that the several pairs of feeders cannot be run at different voltages will it be necessary to design those feeders for the same amount of drop on each and for different current densities; and it is recommended that the arrangements should be such that each feeder can be controlled separately, as to its station voltage. This point will be dealt with more fully when we deal with station details.

The feeding points having been determined upon, it will next be necessary to design the separate sections in the network which runs from feeder to feeder. A simple application of the economic law is not here always possible, but, if it were, it would, of course, yield the same result as for the feeders, assuming the quality of the cable to be the same in both cases. The reason why this law is not simply applicable, and why in some cases it must be abandoned altogether. is that it is here necessary to limit the drop which takes place in the conductor. Between each feeding point and the mid point between it and the next, there is a certain fall of voltage-drop which is proportional to the average of the current density on that half section, and to the distance between the feeding point and the mid-point specified. This will be rendered clear by reference to fig. 1, where there are

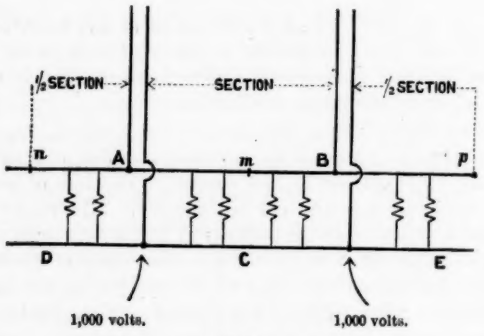


FIG. 1.

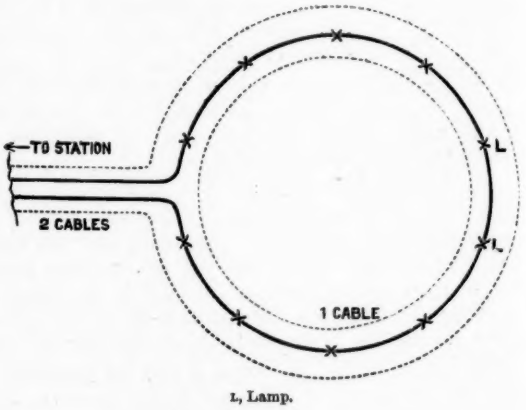
two feeding points, A and B, supplying power at 1,000 volts to the section, C, and to the two half-sections, D and E. Between A and the points, *m* and *n*, which are the mid-points on the sections fed by A, there is a continuous fall of voltage; and similarly between B and the points, *m* and *p*. Fixing our thought on *m*, we find that at full load the voltage there will be less than that at either of the feeding points; while when the section, C, is lightly loaded, the voltage at *m* will not differ appreciably from that at the feeding points. Variation in load on the section will therefore cause a fluctuation in voltage, which will be greatest at the points such as *m*. The question to be immediately determined is—how much of this fluctuation can be tolerated? Clearly there must be a certain amount, namely,

$$v = \Delta \cdot R \cdot L$$

where v is the fluctuation in volts, L is the distance in feet along the conduit, between the feeding point and the point, *m*, R is the resistance of a foot length of the conductor one square inch in section, and Δ is the current density in amperes per square inch throughout the length, L. But, to limit this to a certain value, we may prevent the current density rising above a certain value, besides selecting copper of as high a conductivity as we can obtain. Another and indirect process of reducing the drop, v, would be to shift the feeding points nearer together; but this would only be adopted when, at a later date, there had grown up a larger load on the section than that for which it was designed. If, then, we decide on any given fluctuation, we are compelled to design the mains accordingly, and not by the economic law. Two per cent. fluctuation is the limit of good practice, and will not, in general, make it necessary to use a very expensive section of copper, especially if the working voltage of the mains is high.

The current density having been calculated from the foregoing formula, we may either adopt it throughout the length of conductor on the section, or we may keep the section constant and have a mean density equal to that obtained by the calculation. Owing to the fact that the load is not wholly concentrated at the mid-point, but is taken off at various points along the section, the current is not constant; so that to keep the density constant the mains would have to be tapered. This tapering, however, is only to be recommended where there is no possibility of, at any later date, increasing the current in any part of the section; and as there is usually great probability that the load will be very much raised and the feeding points increased or shifted, it is not well to taper the mains to a constant density of current. We shall, therefore, design the mains to have an average density, on any one section, equal to that obtained by the formula, making them of unform section to suit this figure. For example, on a 1,000-volt circuit a 1 per cent. drop, along a half-section 2,400 feet long, would require the current density not to exceed 500 amperes per square inch. In this case the feeding points would be 4,800 feet apart.

Lastly, we have to consider the design of the extra high tension transmissive conductors, where power is transmitted over several miles. Since there may be complete control over the voltage at the delivery end, the problem resolves



L, Lamp.

FIG. 2.

itself into a simple application of the economic law. Having found the most economical current density, the section of copper is easily obtained.

7. *Underground Cables and Conduits.*—It will here be possible to deal with this subject only in so far as it is concerned with the simplest case of laying a series circuit in iron conduits. There are so many systems of underground conduits and cables, that a lengthy treatise might be written on this section of our subject alone. For arc lighting, pure and simple, however, the system which we shall describe will probably be considered the most suitable. In this system there is a simple circuit of covered wire, drawn into an underground conduit running from lamp to lamp. At intervals there are draw boxes through which the cable may be drawn, and by means of which it may be examined as required. In some parts of the circuit the lead and return cables may be laid in the same conduit, but, for the most part, they will be in different conduits, forming a single line from lamp to lamp, as shown in fig. 2.

Where the power is supplied by means of alternating cur-

rents it is not practicable to put a single conductor in an iron conduit, on account of the damping effect of the iron and the consequent heavy loss of power; in such cases, both the lead and return cables must be carried in the same iron tube, either as concentric cable or as separate cables, and will both have to pass every lamp. Even where continuous currents are used it is sometimes found advisable to run the return and lead cables parallel throughout the circuit, though not necessarily in the same tube. The reason for this is that by running the current back by a different route to that which is taken in running it forward, an induction effect on neighbouring telephone wires is liable to happen. This induction effect is prevented if both cables are carried along the same route within a few inches of one another. This latter mode of arranging the conduits is adopted in the arc lighting for the City of London.

Rubber-covered cables are most commonly employed. An inner stranded conductor, composed of strands of single or sub-stranded copper wire, according to the size and degree of flexibility required, is first served with an envelope of pure rubber, then a thin coating of separator or zinc rubber, and, finally, a very much thicker envelope of vulcanised rubber. Over the insulated cable thus formed there will be woven the hemp or jute protection which is designed to guard the insulation from abrasion while the cable is being drawn into the conduit or moved from place to place. Pure rubber is a material having a high insulating resistance, but owing to the natural oils which it contains there is rapid deterioration when it is exposed to the air or to a moderately high temperature. It cannot, on this account, be used as the sole insulation for the cable; and recourse is had to the process of vulcanisation, which removes the objectionable features. This process consists in the combination of a certain proportion of sulphur with the rubber, under a high temperature and pressure. The separator is designed to prevent the gradual vulcanisation of the inner layer of pure rubber, as contact of the vulcanised material with copper results in chemical action of the sulphur on the metal. Zinc rubber is a mixture of India-rubber and oxide of zinc, and was first used by Hooper as a separator. Between the outer surface of vulcanised rubber and the hemp or jute a binding of tape is frequently wound; while some manufacturers give their cables additional mechanical strength and durability by means of an outer covering of lead. In lead-covered rubber cables the lead has not that insulating function that it has in cables of the Fowler-Waring type, in which the lead is required to keep moisture from a dessicated insulating fibre.

The thickness of insulation depends on the quality of the cable, as well as upon the kind of stranding which is used. Ordinary strands of 14 or 16 gauge add about 30 per cent. to the weight of insulation which is required to obtain the same degree of resistance as for an equal section of solid wire. The strands also increase the weight and diameter, and reduce the resistance of the wire, as compared with the same section of solid wire. The increase in weight is about 2 per cent., and the decrease in resistance about the same amount. The resistance of stranded wire may be taken as about 28 per cent. greater than that of a solid wire of the same diameter, owing to the interspaces of air.

Whatever degree of insulation is specified, it will be found that when the circuit is laid and at work, the resistance will be considerably lower than that of the cable alone. This is chiefly due to the joints and lamp fittings. Consequently, to keep the line resistance high, two precautions about the cable are necessary: (*a*) to have as few joints as possible; (*b*) to make those few joints with the utmost possible care. Where the lamps are not widely apart, it will be possible to avoid joints between the ends of two portions of the cable; but, on long runs, it will sometimes be necessary to join two distinct cables together. It is, however, much easier to avoid cable joints in a series system than in the parallel one; and by proper care, the cables may often be specified in such lengths, that no joints will occur. There are two stages in making a cable joint: connecting the two conductor ends into an efficient mechanical and electrical union, and covering the joint thus made with insulation of the proper quality and thickness. The mechanical protection or braiding should first be removed from a length of each cable, equal to not less than 10 times its diameter; the tapes should next be unwound, and the vulcanised rubber pared away and cut off clean at a right angle; after which, the pure rubber layers should be carefully unwound and kept at hand for replacing when the joint is ready to be insulated.

The character of the joint will depend on the number of strands; but in making all joints, resin and a clean copper bit should be used. The resin may be sprinkled on in powder, or laid on as a thick solution in spirits. The copper bit may be kept clean by rubbing on a resin board, or by dipping it into a saturated solution of sal ammoniac in water. The copper ends of the bared cables must be scrupulously cleaned before the joint is commenced. The following methods are usually adopted:—

(*a*) *To joint two single conductors*, the ends of copper should be filed to a long taper, so that they will lap on to one another without thickening the lap joint; this is called "scarfing." The two scarfed ends should be cleaned and tinned, and then laid on to one another and soldered together. A whipping of thin copper binding wire is now wound round the joint along its entire length and a short distance on each side of it; the whole being again soldered into one solid mass. To reduce the size and remove prickly bits of solder, the joint should be filed evenly to an uniform diameter not very much greater than that of the single wire. The joint is now ready to be insulated.

(*b*) *To joint a 7-strand cable* to a similar cable, the copper ends should be cleaned and soldered up solid; then scarfed and treated in the same way as for a single wire.

(*c*) *To joint a 19-strand cable*, a temporary binder of fine wire is placed round the conductor close to the insulation, and the 12 outer strands are then unwound and turned back over the cable. The inner strands are then soldered up solid, scarfed and jointed as in a 7-strand cable. When the inner joint is filed into shape, the outer strands are "married." A married joint is made by cutting the strands off long and short alternately, and folding the long ones on one cable down over the inner joint to meet the short ones of the other cable. These outer strands need not be scarfed, but may butt against one another. The long and short wires are now soldered together into a compact mass, and a whipping wire is wound over each end of the joint to cover the place where the butt joint occurs at each end. After again soldering, the whole is filed down smooth and even, and is then ready to be insulated.

(*d*) Where thicker cables have to be jointed, the inner set of strands will be scarfed and the other sets married, if a very flexible joint is required; while, if the flexibility need not be great, a greater thickness of inner cable may be scarfed and less number of layers married.

The following directions for insulating a vulcanised rubber cable joint are given by the Silvertown Cable Company:—When the conductor joint is finished, the rubber should be carefully trimmed and cut with as long a bevel as possible, according to the thickness of the rubber; the copper conductor and the bevelled ends should then be rubbed with pure benzole and slightly heated by a spirit lamp. The conductor and the bevelled edges of the rubber should then be wrapped with a pure rubber strip laid on as tightly as possible in one or two layers according to the size; this pure rubber should then be covered with rubber solution, rubbed in so as to exclude air as much as possible; the joint should then stand until thoroughly dry. When the solution is sufficiently dry and will not stick to the fingers, a special rubber strip should then be lapped on spirally, forming an uniform covering over the first coat of pure rubber, care being taken, by lapping tightly and evenly, to exclude all the air. This rubber should be put on in two or more layers, until the diameter is equal to that of the original insulation, and over this a layer of proofed tape should be applied, the whole joint so made slightly exceeding in diameter that of the original insulation. When so completed, the next process is that of vulcanisation. To do this it is necessary to cover the joint with special sheeting cut to the whole width of the joint and firmly rolled round it, making a longitudinal seam, afterwards binding the sheeting over by a strong cotton selvedge tape applied spirally, and as tightly as possible, by hand. This sheeting will serve as a mould to keep the joint together during the process. The joint should then be fixed in the "cure" (a cast-iron box, specially constructed for jointing work) and the cover bolted down; and to prevent damage to the original insulation, as well as to make the box tight, the insulation on each side of the joint for the proper distance to fit the cure should be lapped with two or more

layers of tape. When the cure has thus been made tight, molten sulphur previously melted in a suitable pot should be poured into the cure round the joint through the small hole in the top of the cure, and a thermometer afterwards inserted in this hole to enable the temperature of the sulphur to be noted from time to time. This temperature should be kept as constant as possible, between 290° and 300° Fah., by means of spirit lamps. After the joint has been kept at the full temperature for about half an hour, the molten sulphur compound is run out and the cure cover unbolted. The joint should then be taken out, and the wrappings stripped off, and it will be found to be vulcanised. A rough test of the degree of vulcanisation may be made by trying the thumb nail to indent it, when the joint is quite cool. If the mark of the nail remains on the rubber, or if the rubber is too hard, the joint is a failure, and should be cut out and re-made. If the joint thus examined is found to be in good order, it should be finished off by lapping over all insulating tapes extending, say, over about 2 inches each side of the braiding; this taping to be then painted with shellac varnish.

When insulating with rubber the hands should be kept dry and perfectly clean. When solution is used, it should only be in small quantities, and the spirit allowed to evaporate before the whole is again covered up. The spirit should be of a quality which leaves no residue on evaporation. Special care should be taken that the rubber applied should be brought into immediate contact with the prepared ends, and that no tapes of the original insulation, or foreign material which could conduct moisture, should intervene between the two surfaces to be joined. Unless everything used is perfectly clean, and all air is excluded by careful and tight lapping, the joint may be found to have "blown" in the cure. Special attention, therefore, is required to these points. If the pure rubber appears hard or brittle it can be slightly warmed before using; while the compound tapes can be softened, if necessary, by wiping with benzoline.

(To be continued.)

AUTOMATIC TRANSFORMER SWITCH.

THIS switch is designed to cut off the primary current when the last lamp is switched off from the secondary circuit, and to connect on the primary again immediately a lamp is switched on. Thus the loss during the hours when no lights are on is avoided.

The losses due to these hours is great in shops and offices where the light is required for only a few hours a day, but the cost, we are afraid, of the automatic switch is too great compared with the loss in small consumers' cases. An automatic switch is required only on house-to-house transformers; that being so, such an apparatus would add largely to the first cost. In the sub-station method now in vogue the regulation is by hand, transformers only equal to the load being in use at any moment; in sub-stations, the load is scarcely ever entirely removed, so that the automatic switch would be of no use there, as unless the load is entirely shut off it does not operate; to save losses, however, it is necessary to cut off transformers one by one or a number at a time, as the load varies; this no automatic switch can do.

We must look upon this switch, then, as an adjunct to the house-to-house transformer, where each transformer supplies one consumer, in which case £10 10s. added to the cost of the transformer would more than double the outlay on transformers.

The switch is very ingenious, and we have no doubt will act and perform fully up to the claims of the patentees, Messrs. New and Mayne.

The figure will give an idea of the general arrangement of this switch; it contains three solenoids with laminated sliding cores, two of them operate the high pressure switch, and one of them in the secondary circuit keeps this switch closed so long as any current flows in the secondary; immediately the secondary circuit is opened this solenoid releases a clockwork gear, which pulls open the high-pressure switch, breaking the primary.

It is obvious, now, that closing the secondary would give

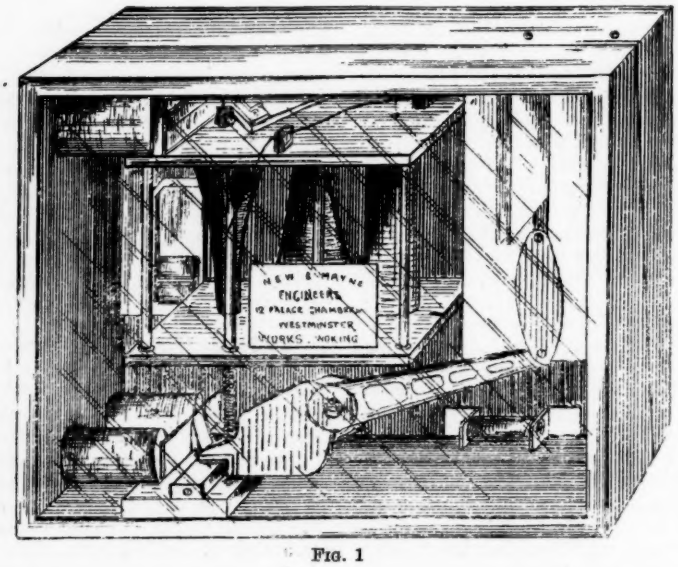


FIG. 1

no current at all, either for lighting or for switching on the primary. The inventors very ingeniously apply a small battery of dry cells, which when the first lamp is switched on sends sufficient current through a magnet to release another clock gear. This clock gear closes the high-pressure switch, and starts the primary current in the transformer again.

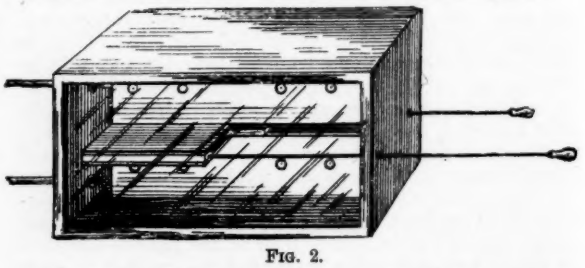


FIG. 2.

It will be seen that the switch comprises quite a number of appliances. Three switches, primary, secondary, and battery, one electro-magnet, three solenoids, with sliding cores, and two clock trains. These mechanisms can be made thoroughly reliable, but failure of action among so many is not quite impossible.

The form of switch used is very good, and it can be used as an ordinary hand switch, as shown in fig. 2, for high pressure primary switches.

ELECTRICAL ENGINEERING AS A PROFESSION.*

ONE of the most eminent and practical working electricians of the country, in a recent article, urges young men to keep out of electrical engineering unless they are willing to work hard and have an instinctive hankering for this line of work. If they think they fulfil these conditions, they should by all means secure a practical education in some good scientific school, and then bend all their energies in one particular direction. Electrical engineering has become specialised, like all other lines of engineering, and there is opportunity for so much work and investigation in any one special line that few men can master more than one. It is particularly noticeable in this connection that the World's Columbian Exposition has had its regular force of electricians and electrical engineers, yet in laying out the lighting and other large engineering schemes it has employed specialists as consulting engineers, and by doing so has prevented several glaring failures, particularly in lighting effects. The demand for such specialists is limited, but the supply is never too great, and is not keeping up in quality with the increased demand.

But, in urging upon young men to make themselves competent specialists, the writer in question did not refer alone to such lofty positions as are only within the intellectual scope of a chosen few, but more particularly to lesser, yet, in their way, equally important lines of work. There are not many engineers in the country that thoroughly understand all the fine and necessary points required in planning and equipping an electric station of medium or large capacity. Nor is there anywhere near supply enough of men who are competent to take charge of a plant, put it into good running condition, keep it in such order that consumers of light or current can feel as sure of their supply as they are of the coming of each day, and at the same time have in mind the fact that while he is maintaining the highest efficiency in the plant, he is remembering that the stockholders are looking to him to operate the plant with a high degree of economy. In this particular line of work there are probably better openings for intelligent, well-trained young men than in any other line. Whatever the work may be—and it is equally true of all lines of engineering—the successful men are, as a rule, those who fully master one branch of their chosen profession.

HEATING BY ELECTRICITY.

BY RANKIN KENNEDY.

WHAT may be called the "resistance" method of electric heating has recently been somewhat fully discussed, but none of the writers on the subject have given any information regarding the durability of the resistance wires embedded in the cement or enamel which binds them to the pot, pan, or kettle, to which the heat is to be imparted.

Besides the liability to cracking or chipping of the enamel and thereby injuring the fine wires, there is the almost certain failure of the resistance wires due to the continual heating and cooling effects—expansion and contraction.

This method of heating has another drawback. The articles to be heated must be specially prepared with resistance wires, and the necessary connections for making contact to the mains, and with the not always unobjectionable enamel or cement.

Of course at present rates for current supply it may be said that the people who can afford to use electric heating apparatus, can also afford to renew them often, and can also afford to pay for their careful handling and maintenance.

But another method of heating by electricity, practised by M. Zipernowski, dispenses with the resistance wires and enamels. In this method the principle of the semi-incandescent lamp is applied; thus if a copper soldering bolt is brought into contact with the tip of a carbon point and a current passed through of large volume, a great deal of heat is generated at the point of contact, which heat is taken up almost wholly by the copper, especially if the contact is made at the bottom of a cavity in the bolt.

It is obvious that this method could be applied in many different ways.

The writer of this article, after numerous experiments, took out a patent No. 9,956, 1890, for still another method of electric heating, in which the induction by alternating currents of secondary currents in the articles to be heated is made use of; thus if an iron pipe closed at one end is filled with water and then placed inside of a coil of wire carrying an alternating current, the water very soon boils, due to the heating of the iron tube by the currents induced in it. This experiment demonstrates the principle of my method, and shows that no electrical contacts or connections to the article to be heated are necessary; no enamels, cements, or resistance wires are required. It will be obvious that this principle can also be applied in very many different ways. At Edinburgh Exhibition, 1891, this method of heating a flat iron was shown, and a description of it will be found in Prof. S. P. Thompson's excellent work on "The Electro-magnet."

Vessels to be heated by this method may require to be specially shaped, but do not require any special electrical preparations of wires, enamels, or contacts; and the same alternating electro-induction apparatus may be used for a variety of different purposes; thus the same apparatus can boil water, heat a flat iron, or cook a rasher of bacon.

This induction method does not lend itself very readily to the production of high temperatures, but is beautifully adapted for such temperatures as are generally in use for cooking and other domestic purposes.

In the chemical laboratory it is especially valuable in working with inflammable or explosive compounds; the heating may be very easily regulated by a choking coil, and therein lies another advantage in this method over the resistance method; in the resistance method used with continuous currents the regulation is effected by inserting external resistances to dissipate the surplus energy as waste. The choking coil regulates without waste.

This induction method is available only where alternating current supply exists, hence no exploiting of this method has been attempted on any scale up till now; but as alternating supplies are now, or very shortly will be, laid on in many towns, the apparatus for this method of heating will be found competing with the other apparatus, about which so much has been said lately.

The apparatus, for whatever purpose it is used, is built on the principle of the transformer, the article to be heated, or a part of it, constituting the secondary winding, and the closed magnetic circuit type of transformer is the best to follow or adopt as a model, it being an animal warmer blooded than a Hedgehog.

* *Scientific American.*

THE ELECTRIC LIGHTING OF BUDA-PESTH.

THE SYSTEMS.

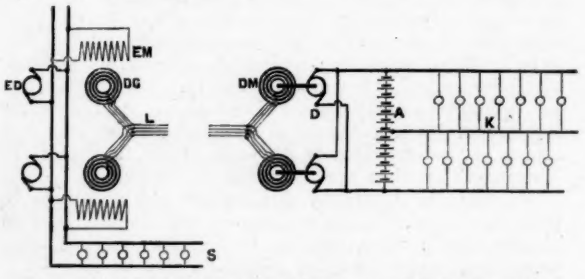
A CONSIDERATION of the way in which our friends on the Continent approach the electric light question ought to be of interest to English electrical men, not only because one of the proposed systems is in some degree novel, but as showing how the foreign community endeavours to protect itself against the contractors.

In their wisdom the authorities look upon competition as a means of obtaining great advantages, and with this end in view they have granted concessions to the Gas Company and to Messrs. Ganz. The two companies are compelled to rigidly adhere to their own schemes, and to prevent collusion between the two, heavy penalties are to be imposed. Messrs. Ganz and Co. are to use the alternating current transformer system, and the Gas Company use a mixed system. We are indebted to Messrs. Schuckert for the following information concerning the scheme of the Gas Company, the plant for which is supplied by Messrs. Schuckert.

The Gas Company will erect an alternating current station about 3 kilometres from the city; from this they will transmit current to a sub-station within the city itself. The high

pressure current drives, at the sub-station, polyphase motors which are coupled direct to continuous current dynamos. These supply direct, and charge a set of accumulators. It will be seen from the sketch that the distributing mains are laid on the three-wire system, with the batteries on the middle wire.

At the alternating current station there will be erected two triple expansion engines, each of 500 H.P., coupled direct to two-phase alternators. The alternators are to work in parallel. They each give 100 ampères at 1,800 volts. The exciters serve to light the station. The high pressure mains are lead covered concentric cables, cased with iron. One cable is kept



A, Accumulators; D, Continuous current dynamo; D G, Polyphased generator; D M, Polyphased motor; E D, Exciting dynamo; E M, Exciting magnets; K, Distributing mains; L, High tension mains; S, Lighting of station.

as reserve. The accumulators at the sub-station are in two batteries, each of 148 cells, with a capacity of 1,500 to 2,200 ampère hours. The continuous current dynamos are wound for 200 volts. The installation has been arranged for 10,000 16 C.P. lamps burning simultaneously, about 16,000 being connected to the mains.

It will be interesting to compare the cost of this installation with that of Messrs. Ganz, and we shall watch the experiment carefully.

Turning now to

How the City Authorities Protect Themselves

from the machinations of electrical contractors, one is surprised to find firms willing to carry out work under such severe restrictions. We select a few clauses from the concessions for the purpose of showing English contractors how much they have to be thankful for.

"The concession holds good for the term of 45 years, calculated from the day of the signature by the community of the capital.

"The contractor is bound to deliver at the office of works, within 30 days after signature, the plans appended to the agreement, in order to obtain a building license and to construct. After such license has been in existence a year, he must begin to give the supply of current throughout the area.

"If, however, the community desires extension of the electric lighting, the contractor is bound to lay the necessary mains if there is a guaranteed consumption for every dekametre run of the main of 100,000 watt-hours for public lighting."

It is here expressly remarked that the contractor has neither a claim as regards the erection of plant for public lighting, nor any prior claim as against other undertakings, but that the municipality has a free disposal of this right, and can, at pleasure, assign the public lighting to any contractor with whom it has already come to an agreement, or who may subsequently become entitled thereto (!!)

Lastly, the contractor is bound always to extend his mains for private lighting as soon as an annual consumption of 750 watts in 500 hours per dekameter run of lead is guaranteed for a year.

If, finally, the community wishes to introduce electric light in any of its streets, and the yearly minimum consumption of 100,000 watts is not entirely guaranteed, but only to one-half, the contractor is still bound to extend the net if the deficient percentage appears made good by a private consumption in watts for 500 hours.

The contractor must alter any main, when required, at his own cost. The council may even, in pressing cases, undertake such work at the cost of the contractor. If such works are executed by the city instead of by the contractor he must at once pay the city for the cost incurred.

In as far as no special agreement has been arrived at between contractor and consumer concerning the price of current, the quantity of current consumed is to be determined by meter. In this case the price for the supply of electric current is as follows:—*a*. After 100 watt-hours current for electric light, 5 kreutzers, at which unit of price a glow lamp at $9\frac{6}{10}$ English normal candles per Carcel hour costs $1\frac{1}{2}$ kreutzers, and an arc lamp at 600 candles per hour 15 kreutzers. *b*. The unit of price for the purpose of the current destined for the electric transfer of power is 4 kreutzers per 100 watt-hours, at which price the 736 watts corresponding to 1 H.P. per hour cost $29\frac{44}{100}$ kreutzers. No charge is made for transformers and meters.

After five years the price of current may be reduced by the authorities if it is proved that the cost of generating is cheaper than at the commencement of supply. Reductions are given if the consumption of current exceeds a certain amount.

Among the conditions for installing new leads the point is included that the consumer has the right of withdrawing from the agreement if the contractor does not begin to supply current within the time stipulated.

In acknowledgment of the concession the contractor must pay to the community a tax on every kilometre of conductor. The contractor, presumably because he cannot help himself, allows the city to participate to the extent of 5 per cent. in the income of the undertaking, including all the gross income for current furnished for lighting and power purposes up to the third year of the undertaking.

After the expiry of the present agreement, *i.e.*, after the end of the conceded term of 45 years the public of Buda-Pesth is authorised:—

To demand the removal of all mains and accessory appliances, in which case the contractor must execute the removal at his own cost in the limit of time prescribed by the authorities, and must on their removal restore the original condition, otherwise the same work will be effected by the authorities at the cost of the contractor.

Or the city may take possession of all leads, appliances and fittings without any compensation or liabilities, not merely in public places, but all leads which the contractor has erected in private localities, buildings, &c.; that is to say the contractor must place his entire main as it was at the time of the expiry of the agreement in working order in the possession of the city without any compensation, gratis and free from any claims or liabilities.

In like manner after the expiry of the term of 45 years the community comes into possession gratis, and without any compensation of the right of using all patents for the production and supply of current possessed by the contractor, and the latter, as far as the management of the Buda-Pesth electrical works, on the same condition on which the contractor has used these patents in his undertaking.

The city has the right of withdrawing the concession from the contractor if he transfers this agreement to another party, if he has not completed and supplied electricity within the stipulated term of one year. If the contractor, without the permission of the authorities, supplies no electric current to the mains for 24 hours, or to single portions for 3 days after the imposition of a penalty, unless the contractor can show that the interruption is due to elementary events or to circumstances which cannot be obviated with the greatest foresight and efforts. If the contractor combines with other contractors to raise the price of the electric current or to prevent its reduction.

Sundry penalties are imposed for minor misdemeanours, and we should imagine that contractors are in for a very happy time.

ELECTRIC LIGHTING OF THE CITY OF WELLINGTON, N.Z.

THE central station of the New Zealand Electrical Syndicate at Wellington is now approaching completion, and our illustration shows one of the large alternators constructed to the designs of Mr. W. B. Esson by the Gülcher Company, of London, who are the contractors for the station. The machine illustrated gives 75 kilowatts, practically 100 elec-

trical horse-power, at a speed of 480 revolutions per minute, with a frequency of 80 complete cycles per second. There will be five of these in the station when completed, with a smaller machine having a capacity of 25 kilowatts, all rope driven, the large by horizontal and the small by vertical compound condensing engines. Allowing for spare plant the station is equal to the supply of 10,000 lamps of 8 candle-power alight simultaneously, or from 25,000 to 30,000 fixed.

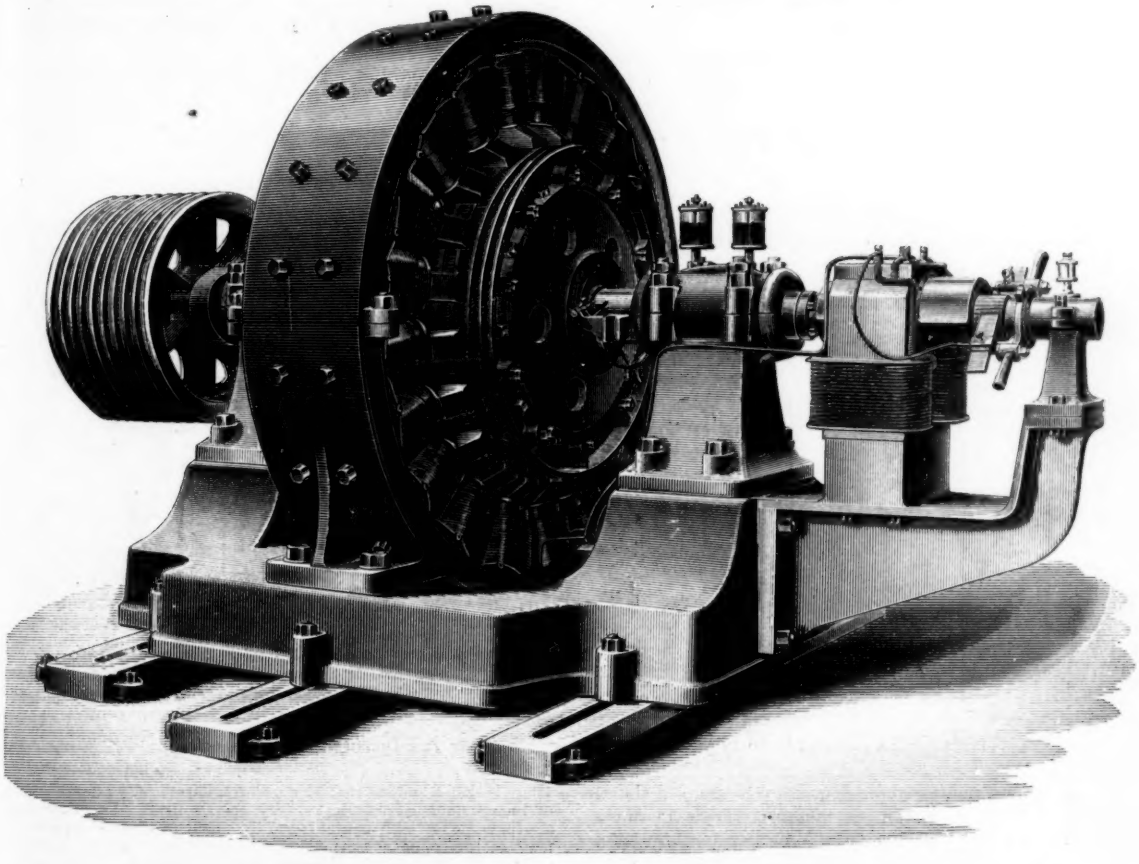
As will be observed from the drawing the alternator is of the revolving armature type. The field system consists of a cast-iron yoke ring in halves, having a section of 50 square inches, from which project radially 20 wrought-iron magnet cores carrying exciting coils, each wound with 254 convolutions of ·203 inch diameter double cotton covered wire. The cores have an area of 28·75 square inches, but are expanded at the inside end, each pole face offering to the armature a surface of 18 inches by $2\frac{7}{8}$ inches.

The armature is of the drum type, and the core is built up of Swedish charcoal iron plates, No. 28 gauge, insulated from each other by paper. The outside diameter of the core is 36 inches, and as it has a radial depth of 3 inches, there is an opening 30 inches in diameter through the centre of the armature in free contact with the air. The plates forming the core are positively driven by 10 delta metal bolts $\frac{3}{8}$-inch diameter notched $\frac{1}{4}$-inch into them, and these bolts passing through massive cast-iron driving discs serve to pull the core plates together as well as to transmit the driving force. The generating coils on the armature are 10 in number, or there are half as many coils as magnet cores. Each coil is wound with 50 convolutions of double cotton covered ribbon, ·25 inch by ·06 inch, and slightly curved to suit the round-up of the armature. Altogether there are 1,000 active conductors; these are all in series, and the working difference of potentials at the collectors is from 2,000 to 2,100 volts. There being only 10 coils there is a space on the core of $1\frac{3}{4}$ inch between adjacent ones, and driving splines of fibre running the full length of the armature occupy the spaces thus left, being firmly screwed on to the core. Before laying the coils on the core the surface is completely covered with sheet mica ·008 inch thick, and the insulation resistance between the generating coils and the frame measured hot after a six hours' run at full load came out at 10 megohms.

The current is collected from a pair of gun-metal rings, one at each end of the armature. These are mounted on ebonite discs, and on each ring rests a pair of brushes fixed in holders, provided with springs and hold off catches. The exciter is directly coupled, and consists of a small shunt wound machine, having a drum armature, 7 inches in diameter, and 9 inches long. The magnets and outside bearing are carried on an extension bracket as shown.

The armature shaft is of Siemens-Martin steel, 5 inches diameter in the body, and $4\frac{1}{2}$ inches in the journals. The main bearings are of hard gun-metal, three diameters in length, each supplied with oil from a pair of visible feed lubricators. The base of the pedestal serves as an oil reservoir. A strong cast-iron bedplate carries the pedestals and yoke ring, and this is supported on three bedding rails, provided with belt-tightening screws.

The exciting current at full load is 21 ampères, and the resistances are: armature 1·25 ohm; field magnets 3·5 ohms; electrical efficiency, excluding losses in exciter, 95·8 per cent.; commercial efficiency, including exciter, 90 per cent.



ALTERNATORS IN PARALLEL.*

By EMIL HUBER.

So much has been written about connecting alternators in parallel that your readers will doubtless be interested in some facts regarding the parallel connection of alternators under different circumstances. The machines referred to are multipolar, flat ring machines, of the Kapp type, for a frequency of 50 to 65, and were constructed by the Oerlikon Company, in Switzerland.

In Schio, Lugano, Bellinzona, Reichenhall and Macerata, such machines for 50, 100 and 150 H.P. are driven, each with a separate turbine either directly coupled or by means of gear wheels. These machines are coupled in parallel without any

* The *Electrical World*.

load resistance as soon as the load on each of the machines is about 25 per cent. of the normal. The connection is made by observing the usual phase indicators as soon as synchronism is approximately established and after regulating for the voltage. In the central station at Zurich, where two machines of 300 H.P. have been running for a year and where two others of like size are in course of construction, the parallel coupling is accomplished by mechanical means without a phase indicator and without any artificial load resistance. The machine to be coupled is brought to approximately synchronous speed by means of a special high pressure turbine; the synchronous speed is observed by a man stationed at the clutch coupling by the relative motion of the teeth on the two parts of the coupling; the mechanical coupling takes place without jar or noise; the coupling of the circuits takes place after regulating the voltage by means of a double-pole switch; there is no variation in the lights.

In the central station at Chur a 400 H.P. turbine drives three alternators of 100 H.P. from a common shaft by means of belts; in this station experiments were made to determine at what load the parallel coupling can take place. It was found that they could be coupled without the use of any load resistances, when approximate synchronism was reached, and when the load was only $1\frac{2}{3}$rds ampères; that is, only $5\frac{1}{2}$ per cent. of the normal load.

The ease with which these machines can be coupled shows itself also in their application as motors; one of the three machines in the Chur station runs a similar machine as a motor in a mill. This motor is started by a small 9 H.P. alternate current motor which starts with a load; when synchronism is reached, the motor is connected to the shafting of the mill. In spite of very variable loads this motor has never fallen out of synchronism for a mean load of 90 H.P.

In the recently started central station at Wasa, in Finland, there are two 100 H.P. alternators run with belts from two compound Oerlikon steam engines. The engineer, who started this station, had never been present at a parallel coupling of alternators, but notwithstanding this he succeeded without any trouble, which is a further proof that these alternators can be coupled in parallel very readily. In this installation, also, there is neither a load resistance nor a special regulator on the steam engine. The same may be said, also, of the multiphase alternators of this company. It is not the intention of this note to enter into the reasons why the coupling of these alternators is so easy, but only to give a practical example of cases where they are so run.

Oerlikon, *May*, 1893.

ON LIGHT AND OTHER HIGH FREQUENCY PHENOMENA.*

By NIKOLA TESLA.

(*Continued from page* 684.)

On the Apparatus and Method of Conversion.

These high frequency currents are obtained in a peculiar manner. The method employed was advanced by me about two years ago in an experimental lecture before the American Institute of Electrical Engineers. A number of ways, as practised in the laboratory, of obtaining these currents either from continuous or low frequency alternating currents is diagrammatically indicated in fig. 1, which will be later described in detail. The general plan is to charge condensers from a direct or alternate current source, preferably of high tension, and to discharge them disruptively, while observing well-known conditions necessary to maintain the oscillations of the current. In view of the general interest taken in high frequency currents, and effects producible by them, it seems to me advisable to dwell at some length upon this method of conversion. In order to give you a clear idea of the action, I will suppose that a continuous current generator is employed, which is often very convenient. It is desirable that the generator should possess such high tension as to be able to break through a small air space. If this is not the case, then auxiliary means have to be resorted to, some of which will be indicated subsequently. When the condensers are charged to a certain potential, the air or insulating space gives way, and a disruptive discharge occurs.

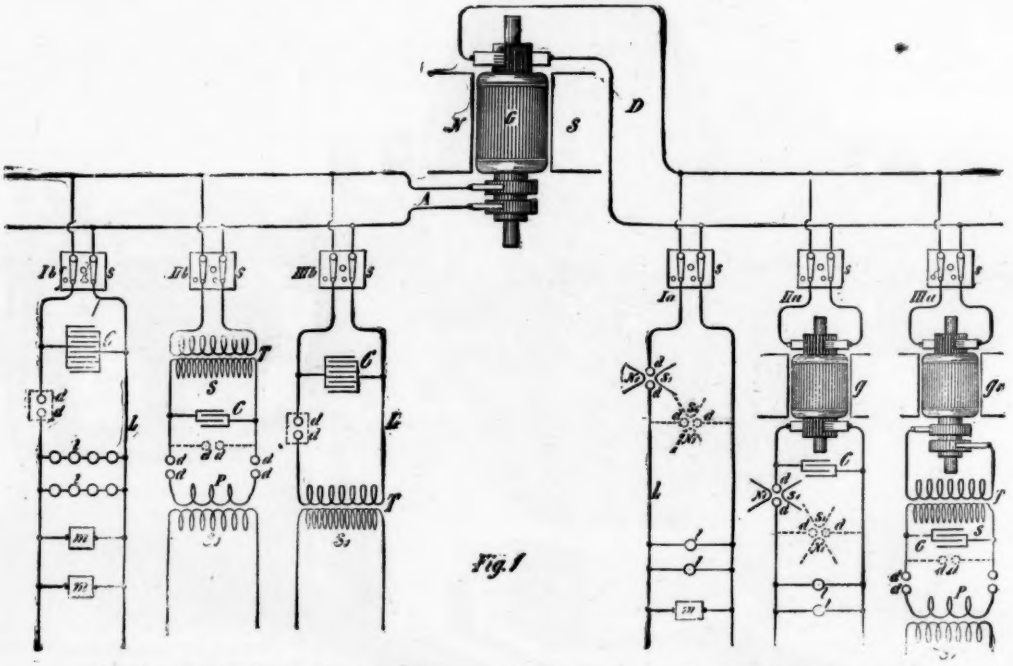


Fig. 1

Plan of Connections Used in the Conversion by Means of the Disruptive Arc Discharge.

There is then a sudden rush of current, and generally a large portion of the accumulated electrical energy spends itself. The condensers are thereupon quickly charged, and the same process is repeated in more or less rapid succession. To produce such sudden rushes of current, it is necessary to observe certain conditions. If the rate at which the condensers are discharged is the same as that at which they are charged, then, clearly, in the assumed case the condensers do not come into play. If the rate of discharge be smaller than the rate of charging, then, again, the condensers cannot play an important part. But if, on the contrary, the rate of discharging is greater than that of charging, then a succession of rushes of current is obtained. It is evident that, if the rate at which the energy is being dissipated by the discharge is very much greater than the rate of supply to the condensers, the sudden rushes will be comparatively few, with long-time intervals between. This always occurs when a condenser of considerable capacity is charged by means of a comparatively small machine. If the rates of supply and dissipation are not widely different, then the rushes of current will be in quicker succession, and this the more, the more nearly equal both the rates are, until natural limitations incident to each case, and depending upon a number of causes, are reached. Thus we are able to obtain from a continuous current generator as rapid a succession of discharges as we like. Of course, the higher the tension of the generator, the smaller need be

* A lecture delivered before the Franklin Institute, at Philadelphia, February 24th, 1893, and before the National Electric Light Association, at St. Louis, Mo., March 1st, 1893.

the capacity of the condensers, and for this reason, principally, it is of advantage to employ a generator of very high tension. Besides, such a generator permits the attaining of greater rates of vibration.

The rushes of current may be of the same direction under the conditions before assumed, but most generally there is an oscillation superimposed upon the fundamental vibration of the current. When the conditions are so determined that there are no oscillations, the current impulses are unidirectional, and thus a means is provided of transforming a continuous current of high tension into a direct current of lower tension, which I think may find employment in the arts.

This method of conversion is exceedingly interesting, and I was much impressed by its beauty when I first conceived it. It is ideal in certain respects. It involves the employment of no mechanical devices of any kind, and it allows of obtaining currents of any desired frequency from an ordinary circuit, direct or alternating. The frequency of the fundamental discharges depending on the relative rates of supply and dissipation can be readily varied within wide limits by simple adjustments of these quantities, and the frequency of the superimposed vibration by the determination of the capacity, self-induction and resistance of the circuit. The potential of the currents, again, may be raised as high as any insulation is capable of withstanding safely by combining capacity and self-induction or by induction in a secondary, which need have but comparatively few turns.

As the conditions are often such that the intermittance or oscillation does not readily establish itself, especially when a direct current source is employed, it is of advantage to associate an interrupter with the arc, and I have, some time ago, indicated the use of an air blast or magnet, or other such device readily at hand. The magnet is employed with special advantage in the conversion of direct currents, as it is then very effective. If the primary source is an alternate current generator, it is desirable, as I have stated on another occasion, that the frequency should be low, and that the currents forming the arc be large, in order to render the magnet more effective.

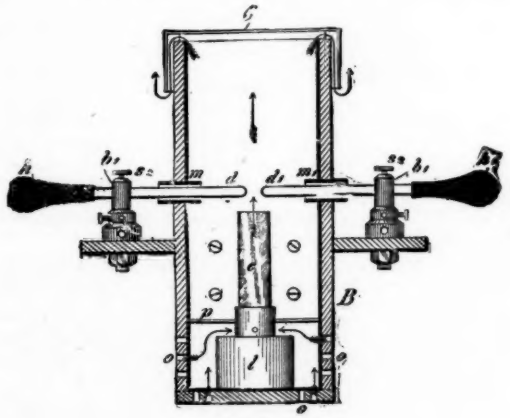


Fig. 3

DISCHARGES WITH HOT AIR DRAFT.

the carbons, and the result is that a smaller E.M.F. in the arc gap is required to maintain a succession of discharges.

Another form of discharger which may be employed with advantage in some cases is illustrated in fig. 3. In this form the discharge rods, d, d_1, pass through perforations in a wooden box, B, which is thickly coated with mica on the inside, as indicated by the heavy lines. The perforations are provided with mica tubes, m, m_1, of some thickness, which are preferably not in contact with the rods, d, d_1. The box has a cover, C, which is a little larger, and descends on the outside of the box. The spark gap is warmed by a small lamp, l, contained in the box. A plate, p, above the lamp allows the draught to pass only through the chimney, c, of the lamp, the air entering through holes, o, o, in or near the bottom of the box and following the path indicated by the arrows. When the discharger is in operation the door of the box is closed so that the light of the arc is not visible outside. It is desirable to exclude the light as perfectly as possible, as it interferes with some experiments. This form of discharger is simple and very effective when properly manipulated. The air being warmed to a certain temperature has its insulating power impaired, it becomes dielectrically weak, as it were, and the consequence is that the arc can be established at much greater distance. The air should, of course, be sufficiently insulating to allow the discharge to pass through the gap *disruptively*. The arc formed under such conditions, when long, may be made extremely sensitive, and the weak draught through the lamp chimney, c, is quite sufficient to produce rapid interruptions. The adjustment is made by regulating the temperature and velocity of the draught. Instead of using a lamp it answers the purpose to provide for a draught of warm air in other ways. A very simple way which has been practised is to enclose the arc in a long vertical tube with plates on the top and bottom for regulating the temperature and velocity of the air current. Some provision had to be made for deadening the sound.

The air may be rendered dielectrically weak also by rarefaction. Dischargers of this kind have likewise been used by me in connection with the magnet. A large tube is for this purpose provided with heavy electrodes of carbon or metal, between which the discharge is

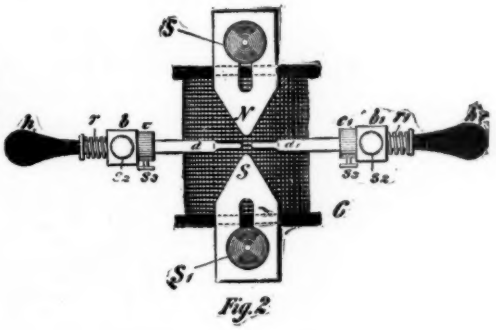


Fig. 2

FORM OF DISCHARGER WITH MAGNET USED IN THE DIRECT CURRENT CONVERSION.

A form of such discharger with a magnet which has been found convenient, and adopted after some trials, in the conversion of direct currents particularly, is illustrated in fig. 2. N, S, are the pole pieces of a very strong magnet which is excited by a coil, C. The pole pieces are slotted for adjustment, and can be fastened in any position by screws, s, s_1. The discharge rods, d, d_1, thinned down on the ends in order to allow a closer approach of the magnetic pole pieces, pass through the columns of brass, b, b_1, and are fastened in position by screws, s_2, s_2. Springs, r, r_1, and collars, c, c_1, are slipped on the rods, the latter serving to set the points of the rods at a certain suitable distance by means of screws, s_3, s_3, and the former to draw the points apart. When it is desired to start the arc, one of the hard rubber handles, h, h_1, is tapped quickly with the hand, whereby the points of the rods are brought in contact, but are instantly separated by the springs, r, r_1. Such an arrangement has been found to be often necessary, namely, in cases when the E.M.F. was not large enough to cause the discharge to break through the gap, and also when it was desirable to avoid short circuiting of the generator by the metallic contact of the rods. The rapidity of the interruptions of the current with a magnet depends on the intensity of the magnetic field and on the potential difference at the ends of the arc. The interruptions are generally in such quick succession as to produce a musical sound. Years ago it was observed that when a powerful induction coil is discharged between the poles of a strong magnet the discharge produced a loud noise not unlike a small pistol shot. It was vaguely stated that the spark was intensified by the presence of the magnetic field. It is now clear that the discharge current, flowing for some time, was interrupted a great number of times by the magnet, thus producing the sound. The phenomenon is especially marked when the field circuit of a large magnet or dynamo is broken in a powerful magnetic field.

When the current through the gap is comparatively large, it is of advantage to slip on the points of the discharge rods pieces of very hard carbon, and let the arc play between the carbon pieces. This preserves the rods, and besides has the advantage of keeping the air space hotter, as the heat is not conducted away as quickly through

made to pass, the tube being placed in a powerful magnetic field. The exhaustion of the tube is carried to a point at which the discharge breaks through easily, but the pressure should be more than 75 millimetres, at which the ordinary thread discharge occurs. In another form of discharger, combining the features before mentioned, the discharge was made to pass between two adjustable magnetic pole pieces, the space between them being kept at an elevated temperature.

It should be remarked here that when such, or interrupting devices of any kind, are used and the currents are passed through the primary of a disruptive discharge coil, it is not, as a rule, of advantage to produce a number of interruptions of the current per second greater than the natural frequency of vibration of the dynamo supply circuit, which is ordinarily small. It should also be pointed out here, that while the devices mentioned in connection with the disruptive discharges are advantageous under certain conditions, they may be sometimes a source of trouble, as they produce intermittencies and other irregularities in the vibration which it would be very desirable to overcome.

There is, I regret to say, in this beautiful method of conversion a defect, which fortunately is not vital, and which I have been gradually overcoming. I shall best call attention to this defect and indicate a fruitful line of work by comparing the electrical process with its mechanical analogue. The process may be illustrated in this manner. Imagine a tank with a wide opening at the bottom, which is kept closed by spring pressure, but so that it snaps off *suddenly* when the liquid in the tank has reached a certain height. Let the fluid be supplied to the tank by means of a pipe feeding at a certain rate. When the critical height of the liquid is reached, the spring gives way and the bottom of the tank drops out. Instantly the liquid falls through the wide opening, and the spring, reasserting itself, closes the bottom again. The tank is now filled, and after a certain time interval the same process is repeated. It is clear, that if the pipe feeds the fluid quicker than the bottom outlet is capable of letting it pass through, the bottom will remain off and the tank will still overflow. If the rates of supply are exactly equal, then the bottom lid

will remain partially open and no vibration of the same and of the liquid column will generally occur, though it might, if started by some means. But if the inlet pipe does not feed the fluid fast enough for the outlet, then there will be always vibration. Again, in such case, each time the bottom flaps up or down, the spring and the liquid column, if the pliability of the spring and the inertia of the moving parts are properly chosen, will perform independent vibrations. In this analogue the fluid may be likened to electricity or electrical energy, the tank to the condenser, the spring to the dielectric, and the pipe to the conductor through which electricity is supplied to the condenser. To make this analogy quite complete it is necessary to make the assumption, that at the bottom, each time it gives way, is knocked violently against a non-elastic stop, this impact involving some loss of energy, and that, besides, some dissipation of energy results, due to frictional losses. In the preceding analogue the liquid is supposed to be under a steady pressure. If the pressure of the fluid be assumed to vary rhythmically, this may be taken as corresponding to the case of an alternating current. The process is then not quite as simple to consider, but the action is the same in principle.

It is desirable, in order to maintain the vibration economically, to reduce the impact and frictional losses as much as possible. As regards the latter, which in the electrical analogue correspond to the losses due to the resistance of the circuits, it is impossible to obviate them entirely, but they can be reduced to a minimum by a proper selection of the dimensions of the circuits and by the employment of thin conductors in the forms of strands. But the loss of energy caused by the first breaking through of the dielectric—which in the above example corresponds to the violent knock of the bottom against the inelastic stop—would be more important to overcome. At the moment of the breaking through, the air space has a very high resistance, which is probably reduced to a very small value when the current has reached some strength, and the space is brought to a high temperature. It would materially diminish the loss of energy if the space were always kept at an extremely high temperature, but then there would be no disruptive break. By warming the space moderately by means of a lamp or otherwise, the economy as far as the arc is concerned is sensibly increased. But the magnet or other interrupting device does not diminish the loss in the arc. Likewise, a jet of air only facilitates the carrying off of the energy. Air, or a gas in general, behaves curiously in this respect. When two bodies, charged to a very high potential, discharge disruptively through an air space, any amount of energy may be carried off by the air. This energy is evidently dissipated by bodily carriers, in impact and collisional losses of the molecules. The exchange of the molecules in the space occurs with inconceivable rapidity. A powerful discharge taking place between two electrodes, they may remain entirely cool, and yet the loss in the air may represent any amount of energy. It is perfectly practicable, with very great potential differences in the gap, to dissipate several horse-power in the arc of the discharge without even noticing a small increase in the temperature of the electrodes. All the frictional losses occur then practically in the air. If the exchange of the air molecules is prevented, as by enclosing the air hermetically, the gas inside of the vessel is brought quickly to a high temperature, even with a very small discharge. It is difficult to estimate how much of the energy is lost in sound waves, audible or not, in a powerful discharge. When the currents through the gap are large, the electrodes may become rapidly heated, but this is not a reliable measure of the energy wasted in the arc, as the loss through the gap itself may be comparatively small. The air or a gas in general is, at ordinary pressures at least, clearly not the best medium through which a disruptive discharge should occur. Air or other gas under great pressure is of course a much more suitable medium for the discharge gap. I have carried on long-continued experiments in this direction, unfortunately less practicable on account of the difficulties and expense in getting air under great pressure. But even if the medium in the discharge space is solid or liquid, still the same losses take place, though they are generally smaller, for just as soon as the arc is established the solid or liquid is volatilised. Indeed, there is no body known which would not be disintegrated by the arc, and it is an open question among scientific men whether an arc discharge could occur at all in the air itself without the particles of the electrodes being torn off. When the current through the gap is very small and the arc very long, I believe that a relatively considerable amount of heat is taken up in the disintegration of the electrodes, which partially on this account may remain quite cold.

The ideal medium for a discharge gap should only *crack*, and the ideal electrode should be of some material which cannot be disintegrated. With small currents through the gap, it is best to employ aluminum, but not when the currents are large. The disruptive break in the air, or more or less in any ordinary medium, is not of the nature of a crack, but it is rather comparable to the piercing of innumerable bullets through a mass offering great frictional resistance to the motion of the bullets, this involving considerable loss of energy. A medium which would merely crack when strained electrostatically—and this possibly might be the case with a perfect vacuum, that is, pure ether—would involve a very small loss in the gap, so small as to be entirely negligible, at least theoretically, because a crack may be produced by an infinitely small displacement. In exhausting an oblong bulb provided with two aluminum terminals with the greatest care, I have succeeded in producing such a vacuum, that the secondary discharge of a disruptive discharge coil would break disruptively through the bulb in the form of fine spark streams. The curious point was that the discharge would completely ignore the terminals, and start far behind the two aluminum plates which served as electrodes. This extraordinarily high vacuum could only be maintained for a very short while. To return to the ideal medium, think, for the sake of illustration, of a piece of glass or similar body clamped in a vice, and the latter lightened more and more. At a certain point a minute increase of the pressure will cause the glass to crack. The loss of energy involved in splitting the glass may be practically nothing; for though the force is great, the displacement need be but extremely small. Now imagine that the glass would possess the property of closing again perfectly the crack upon a minute diminution of the pressure. This is the way the dielectric in the discharge space should behave. But inasmuch as there would be always some loss in the gap, the medium, which should be continuous, should exchange through the gap at a rapid rate. In the preceding example, the glass being perfectly closed, it would mean that the dielectric in the discharge space possesses a great insulating power; the glass being cracked, it would signify that the medium in the space is a good conductor. The dielectric should vary enormously in resistance by minute variations of the E.M.F. across the discharge space. This condition is attained, but in an extremely imperfect manner, by warming the air space to a certain critical temperature, dependent on the E.M.F. across the gap, or by otherwise impairing the insulating power of the air. But as a matter of fact, the air does never break down *disruptively*, if this term be rigorously interpreted, for before the sudden rush of the current occurs, there is always a weak current preceding it, which rises first gradually, and then with comparative suddenness. That is the reason why the rate of change is very much greater when glass, for instance, is broken through, than when the break takes place through an air space of equivalent dielectric strength. As a medium for the discharge space, a solid, or even a liquid would be preferable therefore. It is somewhat difficult to conceive of a solid body which would possess the property of closing instantly after it has been cracked. But a liquid, especially under great pressure, behaves practically like a solid, while it possesses the property of closing the crack. Hence it was thought that a liquid insulator might be more suitable as a dielectric than air. Following out this idea, a number of different forms of dischargers, in which a variety of such insulators, sometimes under great pressure, were employed, have been experimented upon. It is thought sufficient to dwell in a few words upon one of the forms experimented upon. One of these dischargers is illustrated in figs. 4*a* and 4*b*.

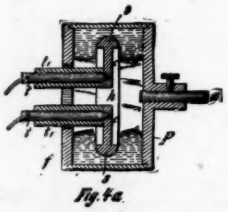


Fig. 4a.

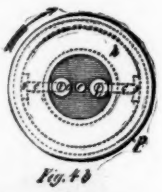


Fig. 4b

FORM OF DISCHARGER WITH LIQUID INTERRUPTER.

A hollow metal pulley, P (fig. 4*a*), was fastened upon an arbour, *a*, which by suitable means was rotated at a considerable speed. In the inside of the pulley, but disconnected from the same, was supported a thin disc, *h* (which is shown thick for the sake of clearness), of hard rubber, in which there were embedded two metal segments, *s*, *s*, with metallic extensions, *e*, *e*, into which were screwed conducting terminals, *t*, *t*, covered with thick tubes of hard rubber, t_1, t_1. The rubber disc, *h*, with its metallic segments, *s*, *s*, was finished in a lathe, and its entire surface highly polished so as to offer the smallest possible frictional resistance to the motion through a fluid. In the hollow of the pulley an insulating liquid such as a thin oil was poured so as to reach very nearly to the opening left in the flange, *f*, which was screwed tightly on the front side of the pulley. The terminals, *t*, *t*, were connected to the opposite coatings of a battery of condensers so that the discharge occurred through the liquid. When the pulley was rotated the liquid was forced against the rim of the pulley and considerable fluid pressure resulted. In this simple way the discharge gap was filled with a medium which behaved practically like a solid, which possessed the quality of closing instantly upon the occurrence of the break, and which moreover was circulating through the gap at a very rapid rate. Very powerful effects were produced by dischargers of this kind with liquid interrupters, of which a number of different forms were made. It was found that, as expected, a longer spark for a given length of wire was obtainable in this way than by using air as an interrupting device. Generally the speed, and therefore also the fluid pressure, was limited by reason of the fluid friction, in the form of discharger described, but the practically obtainable speed was more than sufficient to produce a number of breaks suitable for the circuits ordinarily used. In some instances the metal pulley, *p*, was provided with a few projections inwardly, and a definite number of breaks was then produced which could be computed from the speed of rotation of the pulley. Experiments were also carried on with liquids of different insulating power with the view of reducing the loss in the arc. When an insulating liquid is moderately warmed the loss in the arc is diminished.

A point of some importance was noted in experiments with various dischargers of this kind. It was found, for instance, that whereas the conditions maintained in these forms were favourable for the production of a great spark length, the current so obtained were not best suited to the production of light effects. Experience undoubtedly has shown, that for such purposes, a harmonic rise and fall of the potential is preferable. Be it that a solid is rendered incandescent, or phosphorescent, or be it that energy is transmitted by condenser coating through the glass, it is quite certain that a harmonically rising and falling potential produces less destructive action, and that the vacuum is more permanently maintained. This would be easily explained if it were ascertained that the process going on in an exhausted vessel is of an electrolytic nature.

(To be continued.)

BRIGHTON ELECTRIC LIGHTING.

THE Brighton Town Council having applied to the Local Government Board for sanction to borrow £8,200 for the purposes of electric lighting, an inquiry was held yesterday, at the Town Hall, Brighton, by the Inspector appointed by the Board, Mr. Thomas Codrington, M.Inst.C.E. Mr. Boxall, barrister, appeared on behalf of the Corporation, accompanied by the deputy town clerk (Mr. H. Talbot). There were also present the town clerk (Mr. Francis J. Tillstone), Mr. Stevens (the borough accountant), and Mr. Wright (the electrical engineer).

Mr. BOXALL, in laying the case for the Corporation before the Inspector, said it was proposed about 1890 to have an installation which should provide a current equal to 10,000 16-C.P. lamps, 50 per cent. of the lamps to be in use at the same time, the installation to be by means of underground mains, and the original lighting to extend only over a limited area. An inquiry was held on April 29th, 1890, on an application by the Town Council for the sanction of the Local Government Board to a loan of £30,000 for the purpose of the installation, and £2,500 for a site. The estimates then submitted to the Local Government Board were: For the land, £2,500, which covered the actual expenditure for the site; for the building, £3,000; for boilers, engines, dynamos, &c., £8,000; for instruments, £800; for storage batteries, £5,500; for mains and distributing services, £9,600; and for house service, including meters, &c., £3,100. In that way the total amount of £32,500 was arrived at. That loan was sanctioned, and the works were executed by contracts amounting altogether to £29,429, exclusive of the £2,500 for the site, making altogether £31,929. It would be seen that this was very nearly the total amount of the loan, and as might be expected in a work of such magnitude, the actual expense of carrying out these contracts exceeded in a considerable degree the amount of the original estimates. Certain modifications were also resolved on by the committee, and in one instance these resulted in a considerable temporary saving. The estimates provided for storage batteries £5,500. That was for two sets of batteries, and on the advice of the engineer, the Town Council arranged to have one set of storage batteries only. That was sufficient for temporary purposes, and a saving was effected by only spending the actual necessary amount at that particular time. The total saving on that modification was £2,142 13s. 7d., but as a set-off to that saving, it was found necessary to extend the mains to the western boundary of the borough, and not only were the mains extended in some places, but some small parts of the works originally estimated for were found to be less pressing and were not done. He thought Bartholomew's, Market Street, and part of the Old Steine were not supplied with mains at that time, it being found that there was no pressing necessity for the work. On the other hand, the additional work that was pressing swallowed up the balance that had been saved in this way, and some further sums were expended. On September 15th, 1891, the supply of electricity to the public commenced. From that date there was an immediate and increasing demand for electricity, and the Town Council soon arrived at the conclusion that a fresh extension of the system was absolutely necessary. The work was proceeded with at once. Application was made to the Local Government Board for their sanction to a loan, and on February 10th, 1892, an enquiry was held as to the proposed loan of £8,500. At the time when that enquiry was held, a considerable part of the work for which the loan was required had in fact been done, but the figures put before the inspector were: £7,300 for extra mains, and £1,200 for instruments and contingencies. That loan was sanctioned, the work was proceeded with, and again the exact work estimated for was not carried out. Only one street, Prince Albert Street, he thought, which had been estimated for, was not provided with mains. The estimate had included 14,150 yards of cable; but in point of fact 15,805 yards were actually put down. The measurements worked out at something more than the estimates, and in addition to that, the three-wire system was adopted in part of the district proposed to be lighted, and that involved, of course, one-third more cable than had been originally estimated for. In December, 1892, the Corporation passed a resolution extending the area of supply, which now was no less than 622 acres. That involved the supply of additional machinery, and, of course, of additional mains, and application was made for the sanction of the Local Government Board to a further loan of £37,700. That enquiry was held by the inspector on January 31st, 1893, and in the course of the proceedings, it appeared that among the works estimated for were storage batteries, the second set which had been included in the proposed estimate for the first loan of £30,000, and also the mains he had mentioned, which had been included in the first two estimates, but which had not, in fact, been put down. He understood the inspector then desired fuller information upon these points. A correspondence had since taken place between the Local Government Board and the Town Clerk on this matter, and this application was made on the suggestion of the Local Government Board, contained in their letter of March 17th. The total excess of expenditure was £8,212 13s. 8d., and the excess arose in the following way:—The buildings were originally estimated to cost £3,000 only; they had, in fact, cost £5,059 14s. 7d., which accounted for £2,059 14s. 7d. of that excess. The boilers, engines, and dynamos were originally estimated to cost £8,000, and they had actually cost £10,079 17s., which accounted for a further excess of £2,079 17s. The instruments were estimated originally at £800, and in the second estimate at £800 more, making £1,600 in all; they had, in fact, cost £1,682 11s. 3d., which accounted for a further excess of £82 11s. 3d. On the storage batteries there had, on the other hand, been a saving of £2,142 13s. 7d., but it would be understood that it was now necessary to have a second set of storage batteries, and that that sum was included in the estimates for the further loan which the Corporation had required—not the subject of the present application. The mains and distributing services in the two first loans were estimated at £16,900, but the actual expenditure had been £20,673 12s. 3d., subject to this remark, that part of the cost of the house services was included in that sum. The house services had cost £592 15s. 4d. less t... they were originally estimated for, so that was in some degree a set-off against the foregoing extra expenditure. Then, in the original estimates, there was no allowance for the following:—The installation required for lighting the generating station, which came to £206 16s. 8d.; the engineer's commission, £1,496 17s. 9d.; printing, advertising, clerk of works, &c., £305 19s. Contingencies were originally estimated at £400, but they had exceeded that amount by £261 6s. 7d.; and there was a further item for the proportion of interest and sinking fund during the construction of the work, the total amount of the excess being £8,212 13s. 8d. A loan of this amount was accordingly applied for to cover that excess of expenditure. He need hardly point out that modifications in the work originally intended almost necessarily occurred. The Town Council had to act upon the advice of their engineers in such a matter, and they were desirous of doing the work that was most urgently required. In substance, the estimates were adhered to, but in the particular items to which he had drawn attention the excess of expenditure occurred, and the application he had to make was that the Local Government Board would sanction this loan of £8,200 in order to cover this additional expenditure.

There being no opposition, the proceedings then terminated.

LEGAL.

THE ORIENTAL TELEPHONE COMPANY.

IN the House of Lords on Tuesday, before Lord Halsbury, who presided, Lord Watson, Lord Macnaghten, Lord Morris and Lord Shand, an appeal was argued at the instance of William Addison and others, and the Oriental Telephone and Electric Company, the respondents being Gavin Parker Ness on behalf of himself and all other holders of vendors' shares in the Oriental Telephone Company. The question arising in the appeal was in what manner the profits of the Oriental Telephone Company ought to be applied as between the holders of shares allotted to the vendors and the holders of other shares. The respondent raised an action in 1891 against the appellants, claiming a declaration that no part of the profits of the company were applicable to the payment of any dividend on any of the shares of the company in respect of any year subsequent to the first five years from the date of the incorporation until dividends of 6 per cent. upon the ordinary shares other than the vendors' should have been paid.

The decision of Mr. Justice Kekewich was published in the ELECTRICAL REVIEW for April 24th, 1891 (p. 530).

In the Court of Appeal, however, that decision was reversed, and appeal was now made to the House of Lords.

Mr. Cozens Hardy, Q.C., appeared on behalf of the appellants, and Sir Horace Davey for the respondents.

The case had not concluded when their Lordships adjourned on Tuesday.

NOTES.

Electricity in Hygiene.—An apparatus for electrically transmitting records of the temperature of a fever patient is said to have been devised by M. Tavernier, and to have been tested in Parisian hospitals. In addition to a thermometer, a "fever measurer" is placed under the armpit, and is connected electrically with a recorder in the service doctor's room. When the temperature of the patient rises one or more degrees, a record of this fact is transmitted, so that the physician can ascertain the condition of the patient at any moment without leaving the room, the recorder being provided with a number corresponding with that on the bed of the sick person.

Telephones and the Government.—On Monday last, in the House of Commons, Sir J. Ferguson asked the Postmaster-General what progress had been made under the Telegraph Act, 1892, in the acquisition of the trunk lines of telephones from the companies, in the construction of additional lines, and in the deliminations of the exchanges. Mr. A. Morley said there had been some delay in carrying out the arrangement made by the late Government, owing to the negotiations which were taking place with the telephone companies. Considerable progress had, however, now been made, the establishment of trunk lines would not be long delayed, and progress had been made in the construction of main lines between London and Glasgow and Edinburgh, South Wales, the West of England, and the coal ports of the North. He could hardly hope that these lines would be completed before the end of the financial year.

Traction in Paris.—The Paris Tramways Company is constructing several new lines, two of which are being equipped electrically.

Hanley Appoints an Engineer.—Out of sixty-four applicants for the post of electrical engineer, the General Purposes Committee selected four who appeared before the Council and were questioned as to their qualifications and experience. Mr. George H. Cottam, of London, was appointed at a salary of £200 a year.

The I.E.E. Examination.—The following is a cutting from the *Blackpool Times*:—"I congratulate Mr. W. Chew, Jun., under-manager at the Blackpool gas works, on his being admitted a member of the Institute of Electrical Engineers, to become which candidates are required to pass a very severe examination. Mr. Chew may now add the letters M.I.E.E. to his name." The writer of this paragraph is either utterly ignorant of his subject, or he has been grossly misinformed. There is no examination for I.E.E. candidates.

The Joint Committee on Telephone Companies and Electric Traction.—The Joint Committee of the Houses of Lords and Commons appointed to consider the arrangement of protective clauses for telephone and other companies against the operations of electric railways and tramways met on Monday to decide what course of procedure should be adopted. The Right Hon. Lord Cross was elected chairman, and it was arranged to sit daily, with the exception of Saturdays, from Monday next. Counsel representing the Railways Association, the National Telephone Company, Electric Tramways and Railways, Electric Lighting Companies, and the municipalities of England and Scotland, including the London County Council, will be admitted. Sir Courtenay Boyle, K.C.B., Permanent Secretary of the Board of Trade, will be the first witness examined on Monday next.

The Art of Making Dictionaries.—The art of the lexicographers has developed much of late years. It was but imperfectly understood when one of the greatest of English lexicographers, Dr. Johnson, undertook the task of compiling a dictionary of the English language. The good Doctor worked indifferently well. There was little method in his work; he finished a page when he could, and upon delivering it to the printer, received payment. Judging from an anecdote recently unearthed, the patience of the publishers must have been sorely tried, for when the last page was handed in, the publisher sent word by letter that he enclosed payment to Dr. Johnson, and thanked God he had done with him. To this the Doctor replied in the following manner: "Dr. Johnson thanks Mr. —— for his letter, and is glad to learn that he has the grace to thank God for anything." All this is changed, and by adopting good working systems, the details of which are carried out by a large staff, really good dictionaries have been produced. But it is difficult to obtain a complete dictionary, for enormous additions have been made of recent years to the English vocabulary. New sciences have enriched our everyday language with words which are not met with in the dictionary procurable at a low price. Judging from a prospectus which we have recently received, even this complaint will be no longer fairly uttered. Messrs. Funk and Wagnalls, the well-known New York publishers, who, by the way, have recently opened a London branch, have nearly completed a Standard Dictionary of the English Language, which will be unique. As a single volume dictionary it will stand alone. There are nearly 200 editors engaged upon the various departments of the dictionary, who have been selected from the front rank of English and American scholars. The work has received the commendation of nearly every prominent scholar; rightly so, for the editorial staff is a marvellous combination of the Princes of Learning. Prof. Huxley, Prof. Max Muller, Alexander Graham Bell and Prof. Jebb are men unequalled in their special departments of knowledge; of such is the editorial staff composed. Of the system adopted there are lexicographers more competent than ourselves to give an opinion; but there are features in it which we should find of the utmost value in our daily work.

Rotherham Electric Lighting.—Some time ago an electric lighting committee was formed, but at the last meeting of the Town Council it transpired that the committee had held no meetings, and accordingly, to use the words of the Mayor, appeared to have "died a natural death."

Private Bills in Parliament.—The examiner of standing order proofs in the House of Lords yesterday passed the following Bills:—City and South London Railway; City of London Electric Lighting. In the House of Commons the examiners passed the Electric Lighting Provisional Order (No. 7) Bill relating to Newmarket.

The Institution of Civil Engineers.—The following is a list of some of the premiums awarded for original communications submitted during the session 1892-93. For papers read and discussed at the ordinary meetings:—A Telford Medal and a Telford Premium to Peter William Willans, M.Inst.C.E. (deceased), for his paper on "Steam Engine Trials;" a George Stephenson Medal and a Telford Premium to Edward Hopkinson, M.A., D.Sc., M.Inst.C.E., for his paper on "Electrical Railways: The City and South London Railway." For papers printed in the *Proceedings* without being discussed:—A Telford Premium to Charles Sheibner Du Riche Preller, M.A., Ph.D., Assoc. M.Inst.C.E., for his account of the "Zurich Water Supply, Power, and Electric Works." For papers read at the supplemental meetings of students:—A Miller Prize to Francis Gibson Baily, B.A., Stud. Inst. C.E., for his paper entitled "Some Points in the Regulation of Direct Current Motors."

St. Pancras Electric Lighting.—We understand, says the *Contract Journal*, that the Electricity Committee of the St. Pancras Vestry has discovered the reasons which led recently to a temporary failure of the light. The engineer attributed the defect to improper stoking, that the fires under the two boilers in use had been allowed to get so low that it became necessary to get up steam by a third boiler, and during the time that elapsed in getting up steam the heavy load of the evening came on and led to the temporary depression. The various officials, including the stoker, were examined. Both the engineer and electrician were of opinion that the coal was not bad. The insufficiency of boiler power was not the cause, for at the time of the accident not more than 380 H.P. was required, whereas both boilers were capable of 250 H.P. each. The engineer also stated that the boilers had often been worked to a higher power than the occasion in question, and the electrician in charge stated that although he was not prepared without a personal test to agree what the maximum limit of the boilers was, no question as to their ability to do the work required had been raised. The committee concluded, therefore, that the stoker had not done his duty properly. The stoker has resigned.

The Julien Welding Process.—M. Julien, of Brussels, has devised an electric welding process which is asserted to be superior to both the Benardos and the Thomson methods. Imagine a vessel containing acidulated water, or water having a salt solution and an anode (lead) connected to a source of electricity; then, if the cathode (an iron bar) is plunged into the liquid and a strong electric current passed, oxygen will be evolved at the anode and hydrogen at the cathode. The evolution of gas can be augmented, by increasing the current, to such an extent that the iron, becoming entirely surrounded by hydrogen, is no longer in contact with the solution. This covering of hydrogen offers great resistance to the passing of the current, and considerable heating takes place, which brings both the hydrogen covering and the iron bar to a glowing condition. Very high temperatures can in this way be attained. It is upon this basis that the Julien system is founded. Dr. A. Slaby recently described this process before the Berlin Verein zur Beforderung des Gewerbfleisses. Taking an iron bar forming one pole of a source of electricity, he plunged it into water containing the other pole. On a strong current being passed, that portion of the bar immersed immediately became white hot, and was made into a rivet. It is claimed that with a current at from 100 to 200 volts iron bars of from $\frac{3}{4}$ inch to $1\frac{3}{16}$ths inch can be welded, and that there is no difficulty in regulating the temperature between 800° and 1,200° for forging or welding iron.

Dundee Electric Lighting.—Complaints are being made that the conical electric lamps now fixed upon the standards in the High Street obscure the light to some extent, and also cast deep shadows, whereas the round globes which were at first in use gave a much more brilliant light and cast no shadow. A test of this is to be made when the long evenings come round again.

The Telectroscope.—The *Electrical Engineer* of New York contains an account of an instrument suggested by M. Leon le Pontois for the purpose of transmitting pictures, or views of moving or stationary objects, to long distances. The transmitter is a selenium cell upon which the light from the object falls after modification by a rotating perforated disc. This little shower of rays is converted into a procession of momentary currents, which pass along to the receiver. The receiver is a gas chamber, the valve of which is regulated by in-coming currents of electricity, and thus a calcium light of greater or less intensity is to be produced. We confess that we do not understand how it can become a picture; but that, after all, is a mere detail.

Thermo-Electricity.—At his recent lecture at the Royal Institution, Prof. Dewar gave an interesting proof of the accuracy of the Thomson and Tait thermo-electric diagram. The lines of platinum and copper, if produced in the direction of cooling, are found to meet at a temperature of − 95° C. For palladium and copper, the point of intersection is − 170° C. If the diagram fairly represents the E.M.Fs. of the junctions, it is clear that at the points of intersection the E.M.Fs. should pass through zero and then reverse. With the very low temperatures attainable with oxygen vapour, it is possible to verify these assumptions. With a Cu-Pt junction connected to a galvanometer, the spot of light was observed to fall to zero at − 100° C., and then to reverse. With a Cu-Pd junction, the same effect occurred at about − 170° C.

Parallel Working.—It would be curious to learn what Mr. Hammond meant by his letter to us about parallel working. Although he has been saying, everywhere, that Mr. Mordey's apparatus did not run in parallel in practice, we believe it is generally understood that the Brush Company, if left to carry out its own arrangements, does not take (and never have taken) any steps to enable any other than parallel running to be used in stations that they equip, their switchboards and other arrangements being made for that method, and that method only. This, we understand, is known to Mr. Hammond, as to others in the business. At Bankside there are six alternators, and the number run in parallel varies according to load. They have *never* run other than in parallel, no facilities being provided, or needed for any other way. At Bournemouth they have only one main into the station, and it must puzzle even Mr. Hammond to know how the five alternators in use there are arranged for separate working. It is true that in some stations having the Mordey-Brush electrical plant the separate circuiting plan is used; but this is known to be in no way the fault of that apparatus. It is simply because the engineers have not had proper switchboards, or the engines have been too uneven in turning effort, or the loads have not been beyond the power of single machines. Mr. Hammond seems to think that Mordey set up some sort of a claim to have originated parallel running, but he has expressly disclaimed such an intention, and if Mr. Hammond cares to look up Mordey's 1889 paper in the *Journal* of the Institute of Electrical Engineers, he will find there described everything that had been done in that way (pp. 584—8), and that the author actually drew attention to the parallel working at West Brompton (p. 588), and at p. 678 it will be found that he distinctly disclaimed the introduction of parallel working, and said that his object was merely to state the lines that he thought should be followed to obtain the best results. There has been a vast amount of discussion of this subject since then (in which he has taken no part); but we are not aware of any further advance, and the "Instructions" Mr. Mordey gave in his recent paper (*Journal* of the Institute of Electrical Engineers, February 23rd, 1893, p. 132) merely consisted of the information the Brush Company has been sending out with plant ever since 1889 for the use of the people who were working or erecting it.

Newcastle Electric Lighting.—The authorities have now decided to light Grey Street by electricity.

Newspaper Printing by Electricity.—The *Galway Express* was on 10th inst. printed by electricity for the first time.

Electrocution.—John Osmond, who was recently condemned to death for the murder of his wife and her supposed lover, was executed by electricity on Monday last in Sing Sing prison, New York.

Worcester Electric Lighting.—Mr. W. H. Preece has been appointed engineer to supervise the execution of the electric lighting contracts at a commission of 2½ per cent. on the Brush Company's tender.

Lectures.—On Monday, the 12th inst., Mr. H. Newman Lawrence, M.I.E.E., lectured at the Grand Concert Hall, West Street, Brighton, on "Electro-Medical Eccentricities." The lecture was illustrated by experiments.

Tunbridge Wells Electric Lighting.—A meeting of the Ratepayers' and Property Owners' Association has been held at which the question of electric lighting was brought forward. The general feeling was for the introduction of the new light by the Town Council.

The Collapse of Ford's Opera House at Washington.—It is stated that the collapse of the Washington buildings was caused through some excavations that were being made in the basement to make room for the introduction of electric lighting plant.

Amalgamation.—On the 5th inst. a meeting was held in Vienna to amalgamate the firm of Ganz & Co. and the Vienna International Electricity Company, with a capital of 3,000,000 florins. The new company will undertake the lighting of Buda-Pest.

Fuses.—The action of continuous and alternating currents on fuse metal is being re-discussed in America, and valuable papers on the subject have been read before the Institute of Electrical Engineers of New York, during the past month, by Messrs. J. S. Peck and C. P. Matthews. The experimental results of Mr. W. H. Preece in 1884 have been carefully repeated at the physical laboratories at Cornell University. A re-determination was made for lead and tin, and, at the same time, constants were calculated for various alloys of these metals, which is quite new work. The cooling effect of the terminals is also gone into, and it is found to exert a very considerable variation in the fusing point for different lengths of metal, showing that manufacturers cannot accurately specify their fuse wires unless the length of the specimen is correctly given. An important time element has also to be considered. Abstracts of these papers will be found in the American *Electrical Review* for May 27th, and also in the American *Electrical Engineer* for the same week. The curves will be extremely useful in practical calculations.

Liquid Oxygen.—Liquid oxygen is an excellent insulator. A spark of 25 mm. in air will only discharge across 1 mm. of liquid oxygen. The spark from an induction coil shows the effect of this shortened distance better than the spark from a Wimshurst machine. The magnetic properties of oxygen gas were originally shown by Becquerel, who allowed charcoal to absorb it, and then placed the charcoal, with its charge of gas, in the magnetic field. Prof. Dewar has proved the magnetic properties of liquid oxygen by pouring some into a cup of rock salt and submitting it to a magnetising field between, and a little below, the poles of an electro-magnet. The liquid rises and connects the two poles, or the liquid may be drawn out of a tube by a magnet. Liquid oxygen seems to produce no disturbance in a Hughes induction balance. The magnetic moment of iron being taken as 1,000,000, that of liquid oxygen is about 1,000. Some cotton wool, when saturated with liquid oxygen, was strongly attracted by a magnet, the liquid being sucked out upon the poles. Prof. Dewar predicts that fluorine will also have to be classed as a magnetic gas. Liquid air is also highly insulating, and strongly magnetic.

Oswestry Electric Lighting.—A special meeting of the Council will be held on July 3rd to consider the application of the Oswestry Electric Lighting Company for sanction to apply for a provisional order.

The Royal Society.—The following papers were down for reading before this Society yesterday afternoon :—"On the Elasticity of a Crystal according to Boscovitch," by Lord Kelvin, P.R.S. ; "Electrical Interference Phenomena, somewhat analogous to Newton's rings," by E. H. Barton.

Cable Communications.—The following are the repairs which have been effected to cables during the week ended 13th inst. :—Shanghai-Amoy Cable, repaired June 7th, 1893, Santiago Mole-St. Nicholas Cable, repaired June 7th, 1893. The repair of the latter cable reopens the route Key West-Haiti.

Bradford Electric Lighting.—At a meeting of the Gas and Electricity Committee of the Bradford Corporation, last Friday, it was decided to forward the reports of Mr. Baynes and Mr. Shoolbred, as to the proposed extensions in Bradford of electric lighting to Lord Kelvin, and also that these gentlemen should attend on his Lordship in London. Lord Kelvin will subsequently proceed to Bradford and advise the committee as to what is best to be done.

Great Yarmouth Electric Lighting.—A Local Government Board enquiry will be held at the Town Hall on Monday, June 19th, into the electric light scheme, which involves an outlay of some £15,000. The Inspector will be Mr. F. H. Tulloch, A.M.I.C.E.

Montrose Electric Lighting.—The Police Commission have authorised Mr. Bryson to give a full report on the whole subject of lighting the town by electricity for a fee of 10 guineas.

Nikola Tesla's Paper.—We are indebted to the editors of the New York *Electrical World* for their courtesy in supplying us with the illustrations for Mr. Tesla's paper, the second portion of which appears in this issue.

Fire.—Early on the morning of the 11th inst. a fire broke out at the generating station of the Morecambe Electric Light and Power Company, Limited. The electric lighting of the town will probably be suspended for a few days until alterations previously contemplated can be carried out.

Libel Action Regarding Coal Supplied for St. Pancras Station.—On Tuesday last Mr. Frederick Brough Cameron, carrying on business as a coal merchant under the style of F. B. Cameron & Co., at Pancras Road, sued Mr. David Evans, a lodging house keeper, of 9, Euston Square, and a member of the St. Pancras Vestry, before Mr. Justice Lawrance, sitting without a jury, to recover damages for libel and slander under the following circumstances. The plaintiff had undertaken to supply the St. Pancras Vestry with Nixon's best large smokeless Welsh steam coal for use by the Electricity and Public Lighting Department, and the words complained of were addressed by the defendant to members and officials of the Vestry, and were to the effect that the coals supplied were not according to contract, and contained small coal and slag. On behalf of the plaintiff it was suggested that the coal to which defendant applied his description had been supplied by other contractors before plaintiff's supply was delivered, and the defendant had made a mistake as to the two lots. The defendant alleged that in their natural meaning the words complained of were true in substance and in fact, and were privileged, inasmuch as they were spoken and written in pursuance of his duty as vestryman to interested persons, and without malice. Mr. Bartley Dennis and Mr. Barker appeared for the plaintiff, and the defendant appeared in person. His Lordship was of opinion that the plaintiff was entitled to £25 damages for the slander and libel, and commented strongly upon the way the defendant had acted.

St. Alban's Electric Lighting.—The question of electric lighting is to be brought forward at the next meeting of the City Council.

Fareham Electric Lighting.—The Local Board have renewed the contract with the Electric Light Company for a further period of three years, for 20 arc lamps and 92 incandescent lamps at an inclusive charge of £549 per annum.

Institution of Electrical Engineers.—We are requested to state that as the hat and coat accommodation is very limited at the Galleries of the Institution of Painters in Water Colours, it will be very desirable that gentlemen attending the President's *soirée*, on the 23rd inst., should bring either crush or felt hats.

The Meston Alternating Current Motors.—Several of these new and interesting type of single-phase motors were exhibited at the Royal Institution, on Friday evening last, working from current supplied from the district mains, and suitable for driving sewing machines, small machinery, electric ventilators, &c. There were also shown specimens of the new $\frac{1}{8}$th, $\frac{1}{4}$, and $\frac{1}{2}$ horse-power "Cyclone" type of alternating current motors, kindly lent for the occasion by Messrs. Mackey, Mackey & Co.

The Royal Society and Advertising.—We understand that the secretaries of the Royal Society have circulated among the Fellows, an expression of opinion adopted by the President and Council deprecating the form in which sometimes certificates and statements are prepared by Fellows when reporting on commodities intended for public sale. The President and Council feel that in some cases reports by Fellows inserted in advertisements, are couched in such terms as to have an injurious effect on the status of the society ; and the hope is expressed that in future statements made use of for trade purposes, no suspicion of mercenary motives or commercial partizanship can be attached to the Fellows making them.

Earth Wiring, Telegraph Poles, and Lightning.—A telegraph pole belonging to the Postal Telegraph Department, fixed near Alverthorpe, Yorkshire, was struck by a lightning discharge on Sunday last. The pole carried an arm, one end of which, with its insulator and the pole roof, were carried clean away. The earth wire was melted from top to bottom, only small portions, held by the staples, being left attached to the pole. The pole itself was not damaged, although it is said that it was giving off smoke for half an hour after being struck. This is an interesting example of the efficacy of earth wiring system generally adopted by the Department.

CONTRACTS OPEN AND CLOSED.

OPEN.

Blackpool.—Tenders for electric lighting Victoria Pier, South Shore. Plans and specifications can be had on application to the architect, on or before Saturday, June 17th. J. D. Harker, A.R.I.B.A., architect, 78, King Street, Manchester.

CLOSED.

Dewsbury.—For the construction, supply, and laying down the necessary plant and mains for the supply of electricity in the borough for the Corporation. Accepted tenders :—J. and J. Horsfield, Dewsbury, for boilers, £2,998 ; Crompton & Co , Mansion House Buildings, London, E.C., for engines, dynamos, switchboards, accumulators, &c., £6,257 ; Siemens Bros. & Co., 12, Queen Anne's Gate, S.W., for mains, £3,856.

Portsmouth.—The tender of Mr. J. R. Penning, for keeping in order the electrical apparatus at the Pumping Station, at a cost of £30 for one year, has been accepted.

BUSINESS NOTICES, &c.

J. A. Berly's Universal Electrical Directory for 1893 (12th year), 784 pp. This standard work contains a larger amount of trade information than any other similar publication, and should be in the hands of every engineer or electrician. Free within the Postal Union for 4s.

What Municipal Authorities are Doing.—HANLEY CORPORATION.—Mr. Lobley, the borough surveyor of Hanley, has drawn up a report on the schemes which were propounded sometime ago for the lighting of Hanley. The inhabitants of Hanley do not much exceed 50,000, yet the town authorities move so well with the times that they long ago saw the necessity of providing both a public and private supply of electricity. In September, 1892, the council accepted the tender, amounting to £15,760, of the Brush Electrical Engineering Company for complete equipment of a high tension station. Since then a site has been selected for the central station, contracts for buildings placed, and the work is making satisfactory progress. In the report Mr. Lobley makes a comparison between the system adopted and a low tension system. It serves no useful purpose to do this, for it is needless to point out that each system has inherent advantages of its own. The transforming apparatus will be placed in six sub-stations, low tension mains distributing current to the consumers. The scheme includes lighting public streets as well as private houses. The high pressure mains will be concentrically arranged in one cable with insulating material between the two sets of copper strands—the whole being insulated and protected by outer coverings. This cable is drawn into 3-inch-cast iron pipes, and, as there will be no connections made with it between the junction boxes or transformer stations, it can be drawn out again, and a larger size replaced when the demand requires it. This cable forms a ring main from the works, viâ Bethesda Street and Piccadilly, to the Market Square, and returning viâ Tontine Street and Lichfield Street. The low pressure distribution mains are not concentric, but are laid double in cast-iron troughs, afterwards filled up solid with pure bitumen. These cannot be drawn out and enlarged, and, in any description of conduit, the connections to the different premises renders such a course very costly and difficult. The capacity of these mains is practically increased to any extent desired by reducing the area served by them. This is done by adding transformer stations at the points of most demand. The Local Government Board, after an inquiry, have consented to the council borrowing the sum of £21,000, repayable in 25 years, for the purposes of the order. A contract has been entered into with Mr. C. Cornes for the erection of the buildings for the sum of £2,990. Considerable difficulties have been occasioned in preparing the foundation for the chimney shaft and boiler-house, owing to the outcrop of carbonaceous marl and combustible material. This has been removed and the work is in satisfactory progress. A contract has been entered into with Messrs. John Warner & Son, for a 7-ton travelling crane, for the sum of £137 10s.; and with Mr. Thomas Cass, of Bolton, for supplying the three Lancashire boilers now being made, with his mechanical stokers, for the sum of £270.

ST. PANCRAS VESTRY.

The utilisation of house refuse in generation of electricity has been occupying the minds of the Vestry for some time past, and a report has been lately issued which practically recommends that the second supply station of the Vestry be built with the view to using house refuse as fuel. A technical report is embodied, drawn up by Prof. Henry Robinson and Mr. W. N. Blair (engineer to the Vestry), in which the scheme is supported and set forth in detail. A few extracts will be of use as showing the nature of the project. A site in Georgina Street has been suggested where refuse destructors could be placed in direct communication with the five boilers to produce steam for electric lighting. The space occupied by the cells, refuse-tanks, and roadway adjoining will be enclosed and covered by iron-framed roofs, portions of which are provided to be glazed to give sufficient light without windows in the walls, and the work to be carried on will therefore be less likely to cause complaint of noise or dust. If the capacity of the 18 cells, which it is suggested should be used, be taken at 10 tons per cells per day (and there is every reason to believe that the consumption of refuse will not be below this amount), the depôt will be capable of disposing of 1,080 tons of refuse during the week, and 60 tons would be burnt in the cells under the boilers on Sunday to keep the electric lighting going. This makes the capacity of the depôt 1,140 tons per week without involving any unnecessary Sunday labour. The following is prepared from information obtained last year, and shows the quantity of house refuse collected in the various wards during a summer week and a winter week. The refuse in summer amounts to about 1,336 tons, in winter to about 1,669 tons. The quality of refuse, however, being superior in winter, some part of it might with advantage be burnt in the boiler furnaces, and in this manner some of the surplus would be disposed of. The boilers could probably take 100 tons of refuse per week, using it only when a high rate of evaporation is not required, and resorting to coal when the heavy load comes on in connection with electric lighting. This arrangement would save £10 to £15 per week in coal and disposal of refuse by carting away. It might be found undesirable to burn ordinary summer refuse in the boiler furnaces as the amount of combustible matter which it contains might not be capable of raising the temperature sufficiently to destroy the fumes without a firebrick reverberatory arch over the furnace as in the destructor cells. The following remarks on the electric lighting question are full of significance:—It is desirable for the committee to give consideration to the expediency, either of carrying out another electric lighting station or of increasing the plant at the present station. In this connection it may be pointed out that whereas in other parts of the metropolis the supply given by private companies is extending steadily, there can be no reason for assuming that St. Pancras is exceptional, and that it has reached a limit beyond which it would be impolitic to pass, having in view the obligation that exists under the provisional order to supply electricity to the whole district. The following points should be borne in mind: 1. The present station is only capable of serving 10,000 lamps simultaneously, or about 13,300 lamps installed. 2. At the present time there are about 11,000 lamps installed. 3. That this demand has arisen in less than 18 months. 4. That a new station cannot be got to work in less than 18 months from the present time. The points to be decided are: Will the demand increase during the next 18 months to the extent of more than 2,300 lamps, and is it desirable to extend the mains beyond the present limited area of supply? In the event of its being considered that an extension is desirable, the scheme presented now in connection with the King's Road destructor works would meet the case in a most economical manner. The proposal to establish a refuse destructor station on the King's Road property of the Vestry affords an opportunity for the erection of a second electric lighting station, which can be worked with great economy. By combining the two operations at one station the capital outlay in respect to the production of electricity, will be somewhat less than would be the case if an independent site had to be utilised. There is, therefore, no doubt whatever as to the practicability of raising steam and applying it to engines driving dynamos for generating electricity. The scheme provides for plant to serve 4,100 lamps installed, thus bringing up the capacity of the Vestry's electricity generating plant to 18,100 lamps, or 13,600 lamps simultaneously in use, as against the 10,000 lamps at present. The engine and boiler houses are designed to contain plant to serve double the number of lamps provided for at first, so that future extensions, as hereinafter indicated, can be carried out at any time rapidly and with great economy. It may be observed that the extensions now under consideration are such as are inevitable if the St. Pancras Vestry are to meet the demands which exist in their district. To stand still may involve the question whether the Vestry are *bonâ fide* carrying out their provisional order. The estimated cost of erecting destructors, and the various works in connection therewith would be a sum of £19,000. The cost of disposing of the refuse is at present about 3s. 9d. per ton, including collection, and the cost of dealing with the same quantity at the depôt may be taken at 1s. per ton, to which may be added the cost of collection, estimated at 1s. 6d. per ton, for, with the proposed depôt being so central to the district served, there will be a reduction on the present cost, as the number of journeys per day will be increased. This makes the cost 2s. 6d. per ton, as compared with 3s. 9d. per ton at present, or a saving of 1s. 3d. per ton, which amounts to about £3,700 per annum on the quantity of refuse dealt with at the depôt. There will also be a revenue of several hundreds a year from mortar, &c., produced from the clinkers, and some small value in the clinkers themselves. After allowing for the instalment for interest and repayment of capital, and also for depreciation and maintenance of works, there will remain a clear saving of £2,000 to £2,500 a year on the cost of refuse disposal only. The value of the heat utilised for electricity is estimated separately. The following is the estimated cost of the first instalment of electric lighting works proposed to be carried out in connection with the destructors.

Buildings, with contingencies...	£5,600
Central station plant, ditto	13,170
Mains	12,130
Total...	30,900

The cost of completing the central station plant to serve 7,500 lamps simultaneously, or 10,000 installed, would be £7,600. The additional annual expenses of the electricity department in respect of the King's Road works will be as follows:—

Instalment for 3½ per cent. interest and repayment of loan in 42 years (4·6 per cent. on (£30,900) ...	£1,420
Maintenance and depreciation of new works ...	1,455
Additional staff and miscellaneous fixed expenses ...	1,200
Total amount of fixed expenses ...	£4,075

In addition to this there will be variable expenses for water, oil, coal, &c., depending upon the output and amounting to about ¼d. per unit. If the whole of the proposed plant is devoted to private lighting, about 4,800 lights can be served. Assuming that the consumption will only be 37½ units per lamp per annum (the consumption in St. Pancras last year was 26 units per lamp in private houses, and was 56 units in business premises, therefore the average will be over 40 units if half the demand is in private houses), the total output would be 180,000 units per annum, which would, at 6d. per unit, yield a revenue of £4,500 per annum, while the expenses would be:

Fixed charges (as above)	£4,075 0
Variable expenses 180,000 units at ¼d.	187 10
Total	£4,262 10

This shows a profit of over £200 a year, but as the day load for the whole district could be worked from King's Road with greater economy than from Stanhope Street, a further saving of several hundreds a year would accrue. Inasmuch as lamps for public lighting work for longer periods than private lights, a much better result will be shown if a portion of the proposed plant were to be appropriated to work the 80 new arc lamps that have been proposed as an extension of the present public lighting. If this were carried out the number of private lights served would be reduced from 4,800 to 3,600. The output then would be:

80 arc lamps, using 2,000 units	160,000 units	
3,600 incandescent lamps, using 37½ units ...	135,000 „	
Total ...	295,000 „	

At 6d. per unit this would yield £7,375 per annum, while the cost of production will be:

Fixed charges (as above)	£4,075
Variable expenses, 295,000 units at ¼d.	307
Total	£4,382

Showing a profit of £3,000 per annum, to which should be added (as before) the saving of several hundred a year on the day supply. This £3,000 a year could be devoted either to reducing both the price to private consumers below 6d. and the charge for day current below 3d., or, as an alternative, to reduce the cost of street lighting.

BRADFORD CORPORATION AND THEIR TECHNICAL ADVISERS.

We have recently mentioned the fact that the Town Council are undecided as to the future extension. The Bradford *Daily Argus* has dealt with the matter in a recent issue. The borough is at present at the parting of the ways in connection with its electrical supply, says our contemporary. "Two rival schemes are before the committee, directly antagonistic in principle, both proposed by servants of the Corporation, and both receiving energetic support. One is the "five-wire system," supported by Mr. Shoolbred, the consulting electrical engineer, details and figures of which have not yet been laid before the public, *nor even fully submitted to the consideration of members of the Committee;* the other is the "three-wire system," which has been described at length by Mr. Baynes, acting manager of the electric installation, in a printed report which has now been some weeks in the hands of the Committee, and such of the public as cared to become possessed of a copy. A manuscript report submitted to a Committee on such an important and costly question as this is not sufficient. Each Committeeman ought to have a copy of that report in his personal possession for a sufficient space of time to consider its facts and arguments carefully, and seek the best expert advice he can obtain before he is called upon to give his decision. These facts belong so evidently to the A B C of local government by popular representation that it seems almost absurd to recapitulate them here; but we are led to do so by the intimation, which may or may not be correct, that it is the intention of partisans of one of the two schemes to rush the matter through the Council as speedily as possible, and without leaving that time for its consideration which the interests of the ratepayers demand. The unwisdom of such conduct is surely apparent enough to condemn it at once both inside and outside the Council. A number of instances might be adduced of the inadvisability of rushing into heavy expenditure in connection with electrical matters without due inquiry, but it is sufficient to mention one, that of the Borough of Brighton, where, according to the electrical journals, an installation laid down at a cost of something like £100,000, is being recast, to bring it in accord with what the Council now regard as the best system. It is stated that the Committee intend calling in one of the most noted experts of the day to advise them on the matter. This in itself is a wise step if the enquiry be candid and open, as we trust it will be. There have, however, been cases known where professional experts who have been called upon to advise corporations as to the best of several schemes, have been carefully coached beforehand as to which was the scheme they had to support and which to condemn if they wished to secure further commissions from the same corporation, and when this is the case the inquiry is nothing more than a farce. We should be very sorry indeed to think that such a bogus inquiry could take place in Bradford, and we fail to see wherein any member of the Corporation could advantage himself thereby."

Museum Electric Lighting.—The Fitzwilliam Museum, Cambridge, at which the University Musical Society gave a Jubilee conversazione on Monday, June 12th, was on that occasion for the first time lighted throughout by incandescent lamps. The famous pictures in the galleries were seen to great advantage, as was also the splendid entrance hall of marble. The current was supplied from cells sent from the works of Messrs. J. Stone & Co., of Deptford, and were capable of giving 11,000 watts. Mr. Dodds, Fellow and Bursar of Peterhouse, very kindly placed their engine at the disposal of Messrs. Stone, who were enabled to drive one of their dynamos from it to charge their cells, which were partly discharged on Friday, to enable the committee to judge the effect. In the main galleries were 14 100-C.P. and 12 50-C.P. lamps, the remainder in hall and passages varied from 100 to 16 C.P. The total current used was 110 ampères at 100 volts. The installation was carried out by Mr. Arthur B. Gill, manager of Messrs. Stone's electrical department, and gave universal satisfaction.

Hotel Electric Lighting.—The electric light installation which has been laid down at the Manor Hotel, Datchet, near Windsor, by Messrs. Roger Dawson, Limited, under the superintendence of Mr. A. E. Farrow (now the resident engineer of the Windsor Electric Light Company), as consulting engineer, has commenced running. The plant comprises a Crossley's "Otto" gas engine (horizontal type) indicating 6 H.P., which, obtaining the gas from the Slough Gas Company's mains, drives a "Taunton" dynamo of the latest pattern, having a capacity of 30 ampères at an E.M.F. of 65 volts. There are 27 E.P.S. accumulators, 15L, and a dynamo is fitted with two fly-wheels to run in parallel with the cells, if necessary. There are, further, an ammeter in the charge, and an ammeter in the discharge circuit, a voltmeter to show the E.M.F. on the dynamo circuit, as well as at lamps, with a two-way switch, and an automatic excess current alarm, solenoid type, by which arrangement, if more than 30 ampères are taken from or put in the accumulators, a warning bell rings. The plant supplies 72 8-C.P. lamps.

Electric Cranes at Southampton.—The crane is now in regular work on the Town Quay unloading the vessels of the Clyde Shipping Company as they come in, and the second crane will be erected very shortly, being now almost complete. The maximum speed of lifting of the crane is 200 feet per minute, and by the specification the slewing is to be 400 feet per minute; on test, however, the crane is said to have slewed at the rate of 520 feet per minute. The motors are capable of regulation to lift and slew at any speeds less than the maximum above stated. For lifting, a "Statter" motor absorbing 200 volts and capable of passing 225 ampères and making 600 revolutions per minute is used. This motor runs continuously and drives through worm and worm wheel, the former running in an oil bath. In regular work, lifting 10 to 20 cwt. loads, the average current taken by this motor is about 50 ampères. To lift and lower, the worm wheel is put in and out of gear with the barrel by means of a "Lindsey" transmitter worked by a lever placed on the driving platform. On this platform there are three levers, the one to the transmitter for lifting and lowering is worked by the driver with his right hand. On his left there is a similar lever which works the combined reversing and regulating switches, controlling the slewing. Also on his left there is another lever working a similar switch for the lifting motor. This latter switch is introduced on account of the well known fact that all mechanical clutches, however well they may work as a rule, are liable to become jambed, and accidents frequently happen with steam cranes from this cause. With this electric crane should the transmitter stick, the driver can at once stop his motor by the switch. Sparking at the switch both for lifting and lowering and for slewing is taken up between two carbon points, and there is no appreciable sparking on the switch contacts themselves. These switches are so arranged that the movement of the lever follows to some extent that of the load, and it is therefore easy for the driver to recognise, from the position of his load, what movement he should make with his lever. To lift his load the switch is driven forward, and to lower, it is pulled backward. The middle position, which is determined by a click catch, is the position of rest. For the slewing motion the mid position of the switch corresponds with the position of rest, and forward or backward, right hand or left hand, slewing is marked by arrows. A powerful band brake is provided, and operated by a foot lever, and in addition there is a magnetic brake, which acts and holds the load in case the supply of current to the crane should cease at the moment that the load is being lifted. The slewing motor works at an E.M.F. of 200 volts, and has a capacity of 50 ampères. The average current required to slew is from 15 to 20 ampères. The current for driving the cranes is supplied by the Southampton Electric Light Company, and is fed through special mains laid along the quay to a pair of overhead conductors of silicium bronze wire. The current from these is collected by two clamping blocks, which are arranged in the gantry. These grip the conductors firmly, the pressure being supplied by a screw. The same action locks the travelling gear of the crane, and renders it impossible for the crane to be moved until the clamps have been slackened on the conductors. This gear is controlled by a hand-wheel, which is easily accessible from the top platform of the gantry. The current is led from the clamping blocks in a hard wood channel to the centre pivot of the crane. The pivot is of steel, and is bored through to carry the leads. On the head of the crane pin a pair of collector rings are placed, and from them the current is led to the switchboard. This switchboard, which is additional to the starting switches before described, is fixed in the cabin on the left-hand side of the driver. It contains an ampèremeter, and the main switches and fuses for the lifting and slewing motors, together with switches for six lamps, which are employed to light the crane cabin, and to throw light upon the loads. The lamps for the latter duty are fixed in a reflector attached to the jib. The cranes have been constructed to the specification of Mr. J. G. W. Aldridge, the electrical engineer to the Harbour Commissioners, by Messrs. Statter, working in conjunction with Messrs. Stothert and Pitt, to whom was entrusted the building of the gantries and the crane gearing.

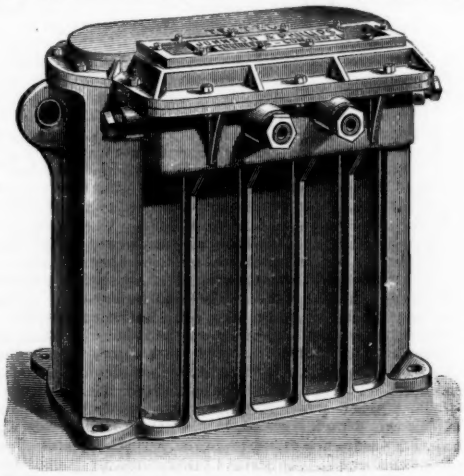
Royal Agricultural Show, Chester.—Messrs. Priestman Bros., Limited, exhibit their patent oil engines of sizes varying from 2 to 20 horse-power. They also exhibit a 7-H.P. horizontal oil engine, together with a 2 H.P. mounted on a trolley specially designed for agricultural and horticultural purposes. The Royal Agricultural Society have adopted the Priestman oil engine for driving the sheep-shearing plant in connection with this year's trials, and it was employed in the Australian colonies during the last shearing season with excellent results. Since the last Royal Show, Messrs. Priestman have further developed the Marine type of oil engine for propelling launches, barges, &c. Messrs. Priestman also exhibit working models of their patent dredger and excavator, which is now at work in all parts of the world, no less than 93 having been supplied to governments alone, besides many more to harbour boards, dock companies, and others. Upwards of 600 of these machines are now in use.

White v. Tussaud.—The defendant, in this case, applied on Wednesday to the Court of Appeal, composed of the Master of the Rolls and Lords Justices Bowen and Kay, for a new trial, alleging misdirection of the jury by the learned judge, Mr. Justice Cave, who heard the case on April 24th last. A report of the case was published in the REVIEW for April 28th. Mr. Tindal Atkinson, Q.C., and Mr. Chitty, appeared for the appellants, and Mr. Witt, Q.C., and Mr. Rose Innes for the respondents. The appeal was dismissed with costs, and the verdict of the jury and judgment were ordered to stand.

The Eastern and South African Telegraph Company, Limited.—The directors notify that letters of allotment for the recent issue of £200,000 4 per cent. (Mauritius subsidy) debentures have been posted.

Belfast Hotel Electric Lighting.—Messrs. D. & G. Graham, Clarence Works, Glasgow, have within the last week completed and started running a large installation of electric light at the Grand Central Hotel, Belfast. This hotel was for the first time opened to the public on Thursday last week. Before tenders were invited for the necessary electrical plant, Mr. J. H. Greenhill, of Belfast, was appointed consulting engineer, and he drew up the specification and subsequently supervised the carrying out of the contract. After severe competition Messrs. D. & G. Graham secured the order. The plant consists of two horizontal engines, each of 100 horse-power made by Messrs. Sharple, two Galloway boilers of the same power, two compound wound dynamos each capable of giving an output of almost 600 16-C.P. lamps. The power to drive these is transmitted through countershafting provided with two of Mather & Platt's patent friction clutches. The switchboard, which measures nine feet by five, is a very fine specimen. It provides that any one of the 14 circuits into which the house is divided may be switched on to either machine, and the current in each section can be separately measured. Each switch is double pole, and is also furnished with a double-pole cut-out. The branch fuse between the two terminals passes under a conical plug, through the centre of which is threaded a wire guide; should the fuse melt the plug is set free and drops into a socket, contact is thus again established and a bye-pass fuse brought into action. Should the cause of the fuse be a short circuit, it will immediately show itself by melting the second fuse, which is made a little heavier than the first; but should the cause be otherwise no extinction of the lamp takes place, and the fuse can be easily replaced whether the current is on or off. A main ammeter, with suitable measuring blocks, is provided, also a voltmeter and a set of resistances for the shunt coils of each machine. In the dining room down each side are placed four six-light electroliers, whilst from the centre of each of the four domes hangs a 1,500 C.P. arc lamp, each fitted with an ornamental counter-weight. On the first floor the drawing room, dining room, and coffee room, are each fitted up with handsome three-light electroliers. All the passages, ante-rooms and bedrooms are illuminated by the electric light. The number of lamps installed is about 700. The generating plant is supplied in duplicate, a very wise precaution. It is a tribute to the care and attention of the contractors that although it was quite impossible to have the countershafting ready till 8 o'clock on Thursday evening, the whole of the installation was started running without the slightest hitch, and is now giving every satisfaction to all concerned. In addition to the contract for lighting, Messrs. D. and G. Graham have also erected a complete electric bell and telephone installation in this hotel. The firm's interests in Ireland are being looked after by their agent Mr. F. A. Porter, 13, Queen Square, Belfast.

J. & P. Transformers.—The engraving gives the general appearance of Messrs. Johnson & Phillips's most recent type of transformer. The case is made of cast iron and is perfectly watertight, glands being provided for both the high and low tension leading wires. This type of transformer is the outcome of considerable experimental work, including the testing of various qualities



of iron, and has resulted in a most satisfactory and approved design. The magnetising current is very small, and the drop of volts between no load and full load is claimed to be considerably less than in other transformers. The firm is prepared to supply these transformers wound for any of the various voltages or ratios, and for any frequency, but it is necessary to specify fully all such requirements at the time of ordering or enquiring. Stock transformers will be of the following voltages: From 2,400 volts to 100 or 50 volts; from 2,000 volts to 100 or 50 volts; from 1,000 volts to 100 or 50 volts.

Dissolution of Partnership.—Messrs. Young and Harrison, trading as the Economic Telephone and Electric Supply Company at 58, North Corridor, Royal Exchange, Manchester, telegraphic contractors, have dissolved partnership, dating from March 18th. Debts are to be paid by Mr. J. R. Young, who continues the business.

Galvanometer Mirrors.—Messrs. Nalder Brothers are now makers of mirrors for galvanometers and other purposes, and also of general optical work.

Electric Lighting of Institution Buildings.—The electric lighting of the main building of the Royal United Service Institution, as well as of the temporary premises and marquees, has been carried out to the plans and specifications of Mr. E. Wingfield Bowles, C.E., the consulting engineer, by the General Electric Power and Traction Company, Limited. The main hall is lighted by four large pendants suspended from the ceiling, each carrying five 100-candle-power lamps. There are also 14 small pendants suspended under the gallery, each carrying three lights. On the gallery itself there are fixed 16 brass standards, placed at suitable intervals, and each carrying three lights. The total actual candle-power illuminating the main hall amounts to 3,540 candle-power. In the crypt, below the main hall, there are three rows of suspended lights, each carrying seven lamps of 32 candle-power. For the temporary lighting of the marquees, tents, &c., about 250 16-candle-power lamps are used.

Electric Lighting of Russian Mills.—Messrs. Mavor and Coulson, of Glasgow, have a large electric lighting contract to execute in Russia, in a woollen mill near St. Petersburg, the largest establishment of the kind in the Czar's dominions. The installation will consist of about 6,000 lamps of 16 candle-power each, and the contract is to include all the machinery and plant required for the generation of the power, its distribution, and its consumption in the form of light, from the boilers and steam engines, dynamos, &c., &c., to the lamps fitted ready for use.

Electric Lighting in Glasgow.—The applications for current for the Kelvinside Electric Light Company represent something like 4,000 lamps of 8 candle-power each, and already the question of putting down additional plant is being considered by the directors. It is expected that two engines of about 120 horse-power each will be running in the course of a week or two. A number of large mansions in Kelvinside have been wired for some months, and are still awaiting current. More wiring is in progress in these big mansions.

Woodhouse and Rawson United.—Mr. F. D. Leslie (receiver and manager on behalf of the debenture holders) announces that with a view to centralising the business, he is closing all branches in the United Kingdom excepting those at Glasgow, Birmingham, Bradford, Manchester and Kidsgrove. The works at Manchester have recently been enlarged by new machinery, &c., having been put down, and the company is now in a position to turn out work thoroughly and promptly.

Hampstead Electric Lighting.—Thirty-one tenders were received for providing the plant for the proposed central electric supply station, and the provision of the necessary mains, &c., in the compulsory area, and nine tenders were received for the erection of a chimney shaft and buildings for the proposed station, with foundations for the machinery. It was decided to advertise again for tenders for the erection of the buildings, and to postpone the opening of the whole of the tenders until the next meeting.

Lists, &c.—A new list has been published by Messrs. W. H. Willcox & Co. of Southwark, in which they give particulars of the various oils manufactured by them. Sight feed lubricators, and oil filters also occupy several pages of space.

We have received from Messrs. Bauer and Betz, of Berlin, a copy of their price list of electromotors.

Mansion Electric Lighting.—Swinton House, a large mansion near Berwick-on-Tweed together with stables and offices, is to have an electric light installation of 140 16-C.P. lamps, with accumulators. Messrs. Graham & Morton of Stirling, have secured the contract, and their engineer Mr. D. B. Rennie will at once commence operations.

The Western Counties and South Wales Telephone Company, Limited.—A general meeting of this company is to be held at 5, Moorgate Street, on July 20th, 1893, at 2 p.m., for the purpose of having an account laid before the meeting, showing the manner in which the winding up has been conducted.

Kingston-upon-Hull Electric Lighting.—The Electric Lighting Committee are inviting applications for the post of electrical engineer to take charge of the electric lighting station. Salary £250 per annum. Some further information will be found among our advertisements.

Eastern and South African Telegraph Company.—We understand that the £200,000 Four per Cent. registered mortgage debentures (Mauritius subsidy) of this company, recently offered for subscription, were subscribed for considerably more than twice over.

Yeadon Electric Lighting.—The Local Board have decided to accept the offer of Messrs. Andrews & Preece of Bradford, to furnish an estimate free of cost of a scheme of lighting Yeadon by means of electricity.

Personal.—Mr. P. C. Middleton who was till lately manager for Walter Andreae & Co., has joined the staff of Messrs. New & Mayne, electrical and general engineers, 12, Palace Chambers, Westminster.

Electrical Exhibition at Derby.—On 12th inst., an electrical exhibition was opened at the Derby Co-operative Hall, promoted by Messrs. L. Rowbottom & Co. The exhibition comprised specimens of all kinds of lighting plant, &c.

National Telephone Company.—Sir Albert K. Rollit, M.P., of Dunster House, Mark Lane, has joined the board of this company.

CITY NOTES.

Elmore's Wire Manufacturing Company, Limited.

THE following report has been issued to the shareholders. We commend it to our readers as a curious piece of financial compilation:—

"The committee of investigation appointed by the shareholders having completed its work, issued its report on March 29th last, and, as in the case of the parent company, retired, leaving the business in the hands of the directors until the necessary working capital had been found.

"The directors have from time to time informed the shareholders as to the position of the company, and asked for funds upon security of the company's first mortgage debentures. Owing to the interest offered not being considered sufficient inducement, these applications met with very little response from the shareholders. In the meantime creditors of the company became very pressing, and, although your managers from their own private moneys paid out a large number of judgments, a time arrived when this could no longer be continued, and it was decided by the first mortgage debenture holders, acting with the consent of the directors and of some of the largest shareholders, to appoint Mr. Stanley Elmore as receiver and manager, for the purpose of protecting the property from wreckage, and to gain time for securing the necessary capital to work the business.

"The estate and assets are now safe from immediate action by hostile creditors, but it becomes necessary to at once adopt the most energetic measures to raise the capital required to preserve the property from passing out of the hands of the shareholders.

"In the opinion of the committee and of the managers, about £48,000 should be raised, and several proposals have been made for doing this. It was at one time suggested that the company should go into voluntary liquidation, with a view to reconstruction, whereby each shareholder should get two £1 shares for each £2 share now held, but that the new £1 share should only be credited with 15s. paid up, and that a call of 5s. per share should be made. This would give the company £33,000. It was proposed to guarantee the success of this scheme by underwriting the issue at a cost of 10 per cent., payable out of the proceeds, equal to £3,300 plus legal and other expenses of reconstruction—say, £1,700—amounting in all to about £5,000 as the cost of reconstruction.

"Whilst this scheme would no doubt give the company the amount required, when added to the £15,000 which is offered to the company on loan, yet it is considered by many of the shareholders that it would be a great hardship to those who cannot afford to pay this call, equal to 10s. upon each share of their present holding, to be compelled to submit to a confiscation of their entire interest in the company for the benefit of the underwriters, who would take up the forfeited shares and pay the call, and thus get a £1 share for less than 5s. It must not be forgotten also that the £5,000, cost of this operation, would have to be deducted from the proceeds of the issue, thus reducing the balance left for working capital.

"The committee and board think that this course should only be adopted as a very last resource, and in view of the fact that £80,000 in cash has been fully subscribed—as we are officially informed—in Paris for the French Elmore Company, and that only a few days ago Elmore's Patent Copper Depositing Company secured the full subscription of its £17,600 of preference shares, every effort should be made by the members of the Wire Company to save their property from confiscation by immediately adopting and carrying out the following proposal, which was laid before a large number of our principal shareholders yesterday, who unanimously passed the following resolution:—

"'That this meeting cordially approves of the method proposed by the board for raising the working capital required by the company, and requests the board to call a formal general meeting to give effect to it as early as possible.'

"To understand the proposal clearly it will be necessary to state the liabilities of the company, which are, approximately, as follows:—

A. Amount due to the bank on mortgage	...	£11,000
B. Amount due to other debenture holders	...	7,000
C. Amount due to unsecured creditors	...	4,000
		£22,000

"A provisional offer has been made to the company of £15,000 for five years at 5 per cent., to be secured by a first mortgage debenture, on the condition that the scheme is carried out immediately in its entirety—namely, that 16,500 of the company's unissued shares be issued at £2 each as preference shares, entitled to 10 per cent. cumulative dividend and to one-half of the remaining profits, and to preference in any distribution of the company's assets, the other half of the profits going to the ordinary shareholders.

"This would give the company a total of £48,000 with which to pay off creditors 'A' and 'C,' and it is believed that the holders of the temporary debentures 'B,' £7,000, will all exchange into an equivalent amount of the preference shares, thus leaving a net amount of 13,000 shares, or £26,000, to be actually subscribed in cash by the shareholders and the public. It is intended that the ordinary shareholders shall have prior right to an allotment of these shares, so that they shall have the full advantage of the exceptional profits to be taken by the proposed new issue.

"The advantage of the scheme will be self-evident. There will not be any expenses of reconstruction, and there will be no confiscation of your present interests; but it is imperative, in order to save the property and business, that the shares be subscribed at once.

"You are doubtless aware that the report of the shareholders' committee of investigation was eminently satisfactory, inasmuch as it expressed the fullest belief in the process, and as to the substantial nature and suitability of the existing buildings and plant. In view of this, and coupled with the concensus of highly favourable opinion expressed by men of the very first rank as scientists who have looked most carefully into the company's business and prospects, the committee and the board feel that it should only be necessary to lay before you a clear statement of the facts as to the company's position, to secure an immediate and hearty response, because, notwithstanding all the unavoidable delay, and the amount of capital already invested in the business, it is admitted on all sides that the process itself is capable of realising handsome profits if carried out on a large scale, which this new and final subscription would enable to be done.

"There can be no doubt whatever that with a sufficient supply of raw copper, and a sufficient amount of capital for working expenses, which this scheme would provide, we possess one of the finest and soundest commercial undertakings in the country.

"The works are capable of turning out 30 to 35 tons of manufactured goods per week, which, after the most careful consideration, based upon the practical experience gained at the works of all the Elmore Companies, it is estimated will produce an annual nett profit, after deducting debenture interest and other charges, of not less than £32,600

Deduct 10 per cent. to preference shares	...	3,300
		£29,300
Half-balance to preference shares	£14,650	
Half-balance to ordinary shares	14,650	
		£29,300

The preference shares will thus receive about £18,000 per annum, which is equal to a dividend of over 50 per cent., leaving over 11 per cent. for the ordinary shares."

Here again we have the same plausible statements which have been put forward time after time. A dividend of 50 per cent. on such a chimerical basis is preposterous.

"The directors believe that with the co-operation of the shareholders it will be possible to carry out the above arrangement, and upon its completion to obtain the services of a strong board of direction.

"Provisional applications for a very considerable amount of the new shares were announced at the shareholders' meeting yesterday, and the directors will be very glad if you will at once intimate by letter to the secretary what number of the shares you would probably be willing to take up when the same have been formally issued.

"Shareholders who cannot attend the general meeting on June 12th are particularly desired to sign and return to the secretary the enclosed proxy."

Mr. J. J. ATKINSON, who presided at the meeting, said that the report of the committee of investigation appointed by the general meeting of the shareholders was issued in April last, from which it would be gathered that, if the working capital required was fully subscribed, there was every prospect of good success for the company. The board and committee jointly made an issue of £25,000 of 6 per cent. first mortgage debentures, which, however, were insufficiently subscribed. The board submitted a scheme to some of the larger shareholders which commended itself to them for adoption, as would be seen from the resolution passed on a previous occasion. The provisional applications for the preference shares, however, had been comparatively few, and fresh negotiations had been opened up with other parties for an advance of the sum required to relieve the company from its liabilities, amounting to £15,000. These negotiations had been carried on through Mr. Hay, whose offer stipulated that the board should get the additional capital required to carry on the works without delay. It would be necessary, therefore, that the resolution should be passed, and certain of the shareholders had agreed to assist the board in the capacity of a consultative committee. The scheme would, to a great extent, meet the views of those shareholders who contended that, as the preference shares were to take so large a share of the profits, only the least possible number of them should be issued. The Chairman then submitted the following resolution:—"That 16,500 unissued ordinary shares of the company be issued, and be called preference shares, entitling the holders thereof to a cumulative preference dividend of 10 per cent. per annum, and to one-half of such remaining profits of the company in each year as shall be applicable to the payment of a dividend on the capital paid up on the shares of the company other than the founders' shares; the said preference shares shall be entitled to priority not only as to dividend, but also as to capital, on a distribution of assets."

The motion was seconded by Mr. ELMORE and opposed by General BEADLE and Mr. BARKWORTH, but was eventually agreed to.

A consultative committee of shareholders was appointed to confer with the board.

Elmore's Foreign and Colonial Company.

THE fourth annual ordinary general meeting of Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, was held on Thursday of last week, at the Cannon Street Hotel.

Mr. F. L. RAWSON presided, and, in moving the adoption of the report and accounts, explained the items of the latter. The liability on securities of the company in connection with loans to the French Elmore Company—£69,274—was no money liability, but meant that

securities to that amount had been lent to the French Company for them to raise money upon. With regard to the balance of profit and loss—£224,000—they must not imagine that that was all profit, as the shares and debentures of the subsidiary companies were taken at par; until the price of the shares of those subsidiary companies had risen it could only be treated as a balance "as per account." The expenses during the past year had been less than before, being £2,924, as against £3,688 and £7,568 in the two previous years. At the last general meeting he stated that the action taken by the directors had saved the French Company, in the success of which they were so largely interested. He believed they would in time get paid their debts in full, and reap a substantial benefit from their large holding, besides getting back the securities which they had lent. It was proposed that the securities received by the French Company from the sale of their undertaking should be held in trust for those interested; that the present £50,000 first mortgage debenture holders of the French Company should retain their position, and that there should be £35,000 second mortgage debentures created; that the Foreign and Colonial Company should receive second mortgage debentures approximately equal to the amount of the first mortgage debentures which they had lent to the French Company, the remainder of the second mortgage debentures being held by the creditors of the French Company; further, that the Foreign and Colonial Company should receive third mortgage debentures equal to the amount of their debt, with interest, and the balance of the securities that they had lent. After the interest was paid upon the debentures, a dividend would be paid upon the £43,000 of preference shares; and then one of the terms was that they should receive no dividend upon their £50,000 vendors' shares until the ordinary shares had received 5 per cent., when the vendors' shares would rank for dividend, and be assimilated to the ordinary shares. Some of the securities they had lent would be returned at once, and others when it had been proved that the debentures of the French Company were of value. In conclusion, the chairman remarked that the French Company had now thoroughly proved the process, and therefore the statements made in the prospectus with regard to its value had been fully borne out.

Mr. E. J. CARSON seconded the motion.

In reply to Mr. INVERARITY, the CHAIRMAN said the shareholders were not asked to sanction the settlement with the French Company, the directors having power to act; but any views expressed with regard to it would be considered.

Mr. INVERARITY opposed the motion, remarking that by passing the report and accounts the shareholders condoned the acts of the directors.

Mr. WEBSTER, a member of a committee appointed by the largest shareholders to confer with the directors, urged that a shareholders' committee, properly constituted, should be appointed to inquire generally into the affairs of the company.

After a further discussion, the report and accounts were adopted on a show of hands.

Mr. J. J. Atkinson, the retiring director, was re-elected.

The Consolidated Telephone Construction and Maintenance Company, Limited.

THE directors' report, which was presented at the twelfth annual general meeting of the company, held at Winchester House, Old Broad Street, London, on Monday last, June 12th, 1893, reads as follows:—"The directors submit to the shareholders the report and accounts of the operations of the company for the year ending March 31st, 1893, showing a net profit of £4,861 17s. 10d., which, with the amount carried forward from last year, leaves a balance of £6,228 6s. 7d., for disposal, after making provision for doubtful debts. Your directors propose to deal with the amount as follows:—To pay a dividend of 2 per cent. for the year on the ordinary shares, and 3 per cent. on the preference shares for the half-year, making 6 per cent. on that class of share for the year; writing off the sum of £357 18s. 9d. for depreciation of plant, machinery and furniture; also £63 16s. 8d. from the cost of new buildings, and reserving £19 11s. 9d. for renewals paid in advance, thus leaving a balance of £1,117 18s. 6d. to carry forward. Resolutions were passed at the extraordinary general meetings on the 9th and duly confirmed on March 28th last, authorising your directors to apply to the Court for leave to deal with the funds arising from the liquidation of the securities of the Telephone Company of Austria, and notice has been given to the company's solicitors that the petition will come before the Court shortly after June 7th. The board regret to state that though the volume of work turned out from the factory has been much the same as last year, the profit has been very much decreased by foreign competitors offering instruments at lower prices. Your directors have again unanimously resolved to relinquish one-half of their fees for the year ending March 31st, 1893. The agencies established have proved fairly remunerative, and the private wire rental business is showing satisfactory expansion. The remaining subsidiary company, the Anglo-Portuguese Telephone Company, in active operation in exchange work has, considering the state of affairs in Portugal, done very well, the progress being shown by the following statement:—

YEAR ENDING MARCH 31ST.

Subscribers.		Rental.		Increase.	
1892.	1893.	1892.	1893.	Subscribers.	Rental.
2,139	2,249	£13,640	£14,447	110	£837

The board deeply regret the loss, by death, of their colleague, Mr. R. Vanzeller. In accordance with the articles of association, the following directors retire by rotation, and, being eligible, offer themselves for re-election, viz., C. L. W. FitzGerald, Esq., and Henry Grëwing, Esq. The auditors, J. G. Griffiths, Esq., F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), and A. E. Green, Esq., F.S.A.A., also retire, and offer themselves for re-election."

At the meeting on Monday last Mr. FitzGerald presided.

The SECRETARY read the notice convening the meeting.

The CHAIRMAN said that they were a little late in getting out the report and accounts this year, but that was simply to do with the auditors. From the report they would see that the gross profit for the year had amounted to £4,861 17s. 10d., which, added to a balance that they had brought forward from last year, made a total of £6,228 odd. That was the amount they had to deal with at the moment. They would observe that meetings had been held, at which they had passed resolutions for the payment of certain sums of money for the preference and ordinary shares which they received from the Austrian company. That company, as was stated in the balance-sheet, had paid the sum of £45,675, leaving £2,325 more to be paid to this company. The reason of the non-payment of that £2,325 was purely a question of accounts to be settled by the Austrian Company with the Austrian Government. Here he would remark that they had called their meeting for the 12th, in the hope that they would have been in a position to tell the shareholders that they had the sanction of the Court to return them their capital. However, they could not hurry the lawyers; they had now been four months over the business, but are still told that it will take nearly another month. He regretted very much that they were not doing so well in the manufacturing business as they had formerly done. That arose from only one cause, *i.e.*, foreign competition, and competition with English firms as well, as they kept on cutting down the prices of telephones, and this company were absolutely powerless in the matter. They must sell at the reduced rates, or not at all. It was an absolute fact that the volume of business turned out of the factory last year and this year were practically the same, but the profit was reduced from £6,000 to £1,848; that was a very serious item, and all they could do was to manage the business as economically as possible. The board were very largely interested in the shares of the company; he (the chairman) having something like 7,000 shares in it. They had given up half their fees for the shareholders' benefit, and so far as the agencies' business was concerned, they might be fairly satisfied, and also with the wire rental business. Of course, all those things were, in their beginning, very slow; still the business was in England to be got, and if it were not for the foreign competition in the manufacturing department, he thought the affairs of the company would have been in a very satisfactory condition. Their only remaining subsidiary company which was really working an exchange was the Anglo-Portuguese Company, which was doing fairly well; it continued progressing steadily, and had paid a dividend of 5 per cent. on its ordinary share capital, besides giving a dividend on the debentures that they held. After a few further remarks, he stated that they had a good sum of money in hand, which they hoped to return very shortly to the shareholders. He then moved the adoption of the report and accounts, and the declaration of dividend as stated in the report above.

Sir ALEXANDER ARMSTRONG, K.C.B., seconded the motion, which, after a short discussion, was carried unanimously.

The retiring directors were re-elected; but on the motion of a shareholder, it was agreed, in the interests of economy, that only one auditor be re-appointed intead of two, as formerly, the auditor elected by the meeting being Mr. J. G. Griffiths.

The Swan United Electric Light Company, Limited.—The directors have resolved to pay an interim dividend at the rate of 5 per cent. per annum in respect of the six months ended March 31st, 1893, as follows:—1s. 9d. per share on the 78,949 ordinary shares of the company, £3 10s. paid; and 2s. 6d. per share on the 19,750 £5 fully paid shares, both free of income tax. The interim dividend will be paid upon the register as it stood on 13th inst., and the warrants will be issued on the 20th inst.

Printing Telegraph and Construction Company of the Agence Havas, Limited.—The statutory meeting of this company took place yesterday at the offices, 12, King William Street, E.C., Colonel W. L. Engledue, chairman, presiding.

Stock Exchange Announcements.—The Stock Exchange Committee have ordered the following to be quoted in the official list:—Montevideo Telephone Company, Limited, ordinary shares Nos. 1 to 15,000; 6 per cent. preference shares, Nos. 1 to 28,000.

Commercial Cable Company, Limited.—A quarterly dividend has been declared of 1½ per cent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending June 11th, 1893, amounted to £759; week ending June 12th, 1892, £745; increase £14; total receipts for half-year, 1893, £20,252; corresponding period, 1892, £18,614; increase £1,638.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 9th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, were £2,768.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.‡	Closing Quotation June 8th.	Closing Quotation, June 15th.	Business done during week ended June 15th, 1893. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,134,640*l*	Anglo-American Telegraph, Limited	Stock	50 — 51	51½ — 52⅓	51⅔	..
2,932,680*l*	Do. do. 6 p. c. Preferred	Stock	92 — 93	94 — 95	95	92½
2,876,140*l*	Do. do. Deferred	Stock	11 — 11½	11½ — 12	11⅞	11⅜
130,000	Brazilian Submarine Telegraph, Limited	10	11¾ — 12¼	11⅜ — 12¼	12⅛	11⅞
36,400*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	101½	..
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	107 —111	107 —111	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3¼ — 3⅜	3 — 3¼	3⅜	3¼
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2 — 2¼	2¼	2 3/16
125,000*l*	Do. do. 4½ per cent. Debenture Stock	Stock	108 —110	107 —109	109	107½
44,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	1½ — 2¼	1½ — 2½	...	...
630,000*l*	City and South London Railway	Stock	37 — 39	37 — 39	...	...
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	11½ — 12	11½ — 12	11 13/16	11½
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	12⅔ — 13	12⅔ — 13	12 13/16	12 11/16
$7,716,000	Commercial Cable, Capital Stock	$100	140 —150	... ... xd	145	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 5/16	3/16 — 5/16 xd	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅝	5¼ — 5⅝	5½	5¼
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	18½ — 19½	18½ — 19½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½ — 3½	2½ — 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅝ — 11⅞	11¾ — 12	11 15/16	11 11/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15½ — 15⅝	15½ — 15⅝	15⅝	15
70,000	Do. 6 p. c. Preference	10	16½ — 17	16¾ — 17¼	17	16¾
105,900*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,294,100*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	112 —115	112 —115	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15⅝
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	} 100	104 —107	104 —107	104¾	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	112 —115	112 —115	...	...
108,700*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	} 100	103 —106	103 —106	...	...
146,800*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	104⅞	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	102 —105	104	102¾
49,900	Electric Construction, Limited, Nos. 101 to 45,100	10	2 — 2½	2 — 2½	2½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1/8 — 1/4	1/8 — 1/4	...	...
91,195	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3/8 — 1/2	3/8 — 1/2	...	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/8 — 3/8	1/8 — 3/8	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	1 — 2	1 — 2	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅜ — 9⅞	9⅜ — 10	9⅞	9⅜
150,042	Do. do. 6 p. c. Preference	10	15½ — 15⅝	15⅝ — 15⅞	15⅞	15⅝
150,000	Great Northern Tel. Company of Copenhagen	10	19½ — 20	19½ — 20	19 9/16	19½
200,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½ — 5½	4½ — 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	6½ — 7½	6½ — 7½	6⅝	6⅝
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	22½ - 23½	22½ — 23½	23¼	23
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	102½	...
17,000	Indo-European Telegraph, Limited	25	40 — 43	40 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
30,000	†Liverpool Electric Supply, £3 10s. paid	5	4⅛ — 4½	4 5/16 — 4 7/16	4⅜	4 1/16
10,000	Do. do. fully paid	5	6½ — 6⅝	6½ — 6⅝	6½	5⅝
37,548	London Platino-Brazilian Telegraph, Limited	10	4 — 6	4 — 6	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	107 —110	...	..
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6 — 6½	6 — 6½	...	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	101 —104 xd	102 —105	104	...
15,000	Monte Video Telephone Co., Ord., Nos. 1 to 15,000 fully paid ...	5	... ...	1½ — 2½	...	...
28,000	Do. do. 6 p. c. Pref., Nos. 1 to 28,000 fully paid	5	... ...	3 — 4	...	...
458,867	National Telephone, Limited, Nos. 1. to 438,984	5	5⅛ — 5⅜	5⅛ — 5⅜	5⅜	5⅛
15,000	Do. 6 p. c. Cum., 1st Preference	10	14⅜ — 15¼	14⅜ — 15½	15 3/16	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	14¼ — 14⅜	14¼ — 14⅜	...	...
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	5⅜ — 5⅝	5⅜ — 5⅝	5 1/16	5⅜
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 —115	113 —117	115	114½
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	... ...	...	...
6,451	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/8 — 1/4	1/8 — 1/4	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 p. c. Guar. Debs., Nos. 1 to 1,000	100	101 —104	101 —104	...	...
11,802	Reuter's Limited	8	6 — 7	5½ — 6½xd	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¼ — 7⅜	7¼ — 7⅜	..	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	...	...
3,381	Submarine Cables Trust	Cert.	119 —124	120 —125	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	2½ — 3	2½ — 3 xd	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	31 — 33	33 — 35	33	31½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	102 —105	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2½ — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 —100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	5½ — 6½	5½ — 6½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	99 —102	100	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7½ — 8	7¼ — 7⅜	...	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅜ — 2¼	1½ — 2	...	...
178,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 —109	106 —109	...	...
222,700*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	..
88,321	West India and Panama Telegraph, Limited	10	1⅛ — 1⅜xd	1⅛ — 1⅜	1 5/16	1¼
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11 — 11½xd	10⅞ — 11½	11	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	9½ — 10½xd	9½ — 10½	10	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	108 —111	108 —111	...	...
$1,214,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
169,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½ — 5⅝	5½ — 5⅝	5⅝	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Birmingham Electric Supply Company, Ordinary of £5 (fully paid) 5¼—5⅜.—Brush Company 4½ per cent. Debenture stock, issued at 1 per cent. premium, 100—103.—Electric and General Investment, shares of £5 (£1 paid) 1½—2½.—Founders' shares, 200—225.—Electric Construction Corporation, 6 per cent. Debentures, 95—98.—Electricity Supply Corporation, Ordinary of £5 5—5½.—House to House Company (£5 paid) 1½—2½.—Do. 7 per cent. Preference of £5, 5—5½.—Do. 6 per cent. Debentures of £100, 97—102.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—5⅝, 1st Preference Cumulative 6 per cent., £5 (fully paid), 6—6¼.—Liverpool Electric Supply Shares of £5 (fully paid), 6⅛—6⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, 6 per cent. £10 Debentures, 101—103. Bank rate of discount, 2½ per cent. (June 15th, 1893).

PROF. KENNEDY'S REPORT ON TESTS OF STEAM DYNAMO AT THAMES DITTON.

THE dynamo tested on May 20th, 1893, was a continuous current shunt-wound machine, with drum armature, made by Messrs. J. H. Holmes & Co., of Newcastle, and marked by the makers No. 673. It was driven direct by a Willans engine (No. 1,430) of the I I type—compound and condensing. The nominal full output of the dynamo was 1,025 ampères at 120 volts, or 123 kilowatts. The machine was first run at this output for six hours continuously, and during this time electrical measurements were made at regular intervals to ensure the uniformity of the load. Sets of indicator diagrams were also taken and the water consumption measured. The mean output during the whole six hours run was 1,010 ampères at 120·0 volts, or 121·2 kilowatts, being thus practically equal to the nominal full load. At starting the speed was 332 revs. per minute, which, at the end of the trial, had only increased to 337 revs. per minute. The shunt current was 14·5 ampères at start, and then fell slightly, remaining steady at 14·0 ampères during the last half of the experiment. The energy expended in magnetising the fields was thus less than 1·4 per cent. of the whole output. During the time when the condensed steam was being measured, the mean output was 1,010·5 ampères at 120·2 volts, which amounts to 121·5 kilowatts or 162·8 electrical horse-power. The condensed steam amounted to 3,314 pounds per hour, which corresponds to 27·3 pounds per unit, or 20·3 pounds per electrical horse-power hour. The indicated horse-power at the same time works out to 190·2, so that the combined efficiency of engine and dynamo (ratio of electrical output at terminals to indicated horse-power) reaches the very high figure of 85·6 per cent. The steam used per I.H.P. hour works out to 17·4 pounds. All these figures represent, as will be seen, the working of the dynamo and engine at a load just below its nominal output. As soon as the six hours' run was over, and the dynamo stopped, I inserted a thermometer with a small bulb well into the end of the armature, as I always do in these tests, where it attained in a few minutes a maximum temperature of 132·5° Fahr. The temperature of the air between the dynamo and the engine was 80·5° Fahr., so that the interior of the armature was 72·0° Fahr. above the temperature of the air, after having completed its six hours' run. The rise of temperature, if measured on the outside of the armature, would of course have been much less. I made, later on, efficiency and steam consumption trials at ¾, ½, and ¼ output, and measured the steam, also, for running the machine excited and light, and also for running the engine alone, the armature being uncoupled. The dynamo was run at approximately the same speed in all cases, and the vacuum was also kept constant, its value being 24·5 inches of mercury (the barometer stood at 29·9 inches) throughout. No doubt with a higher vacuum even better results could be obtained. The detailed figures of all these tests are given in the appended table. Their results are also shown graphically in the diagrams which accompany this report. In fig. 1, the base of the diagram is electrical horse-power, and on this base are drawn curves of indicated horse-power, total water per hour, and mean working pressure reduced to the area of the L.P. piston. The observed points are clearly indicated in the diagram, and it will be seen that the four points in each set lie very closely upon one straight line. From the observations thus rectified the curve of efficiency and the curve of water per indicated and per electrical horse-power hour are worked out, and are plotted on the diagram. A satisfactory point of special importance is the slow rise of the last-named curves, even as far back as half load. This matter, however, rather affects central station work than the probable future duty of this particular machine.

In fig. 2, the base of the diagram is indicated instead of electrical horse-power. I have marked here, on the line giving the total water per hour, the points which correspond to the observed quantities of water used per hour when the engine was running with no load, but at full speed. In fig. 2 I have given also a curve showing the percentage of the total indicated horse-power which is expended, at each load, in useless work, *i.e.*, in overcoming the frictional and other internal losses of the engine and the dynamo. The ordinates of this curve are, of course, in reality no more than the difference between 100 per cent. and the corresponding ordinates of the efficiency curve of fig. 1.

TABLE GIVING THE PRINCIPAL RESULTS OF OBSERVATIONS DURING THE EXPERIMENTS.

Conditions.	I.H.P.	Current. Ampères.	E.M.F. Volts.	Kilowatts.	E.H.P.	Revolutions per minute.	Exciting current. Ampères.	Water used per hour. lbs.
Full power ...	190·2	1,010·5	120·2	121·5	162·8	339	14·0	3,314
Three-quarter power	147·5	746·0	120·5	90·0	120·0	334	12·8	2,631
Half-power ...	108·8	523·5	120·1	62·9	83·9	336·5	11·1	2,048
Quarter-power ...	65·0	263·0	120·2	31·6	42·1	338	10·5	1,384
Excited	...	...	120·0	...	...	346	9·5	722
Light with dynamo	...	...	...	...	...	343	...	580
Do. armature uncoupled ...	...	...	...	...	...	340	...	524

The electrical and other measurements were made upon the standard instruments of the Thames Ditton Works, which are now accepted by all engineers, I believe, as accurate. The steam used was all weighed in a tank placed on a standard weighing machine,

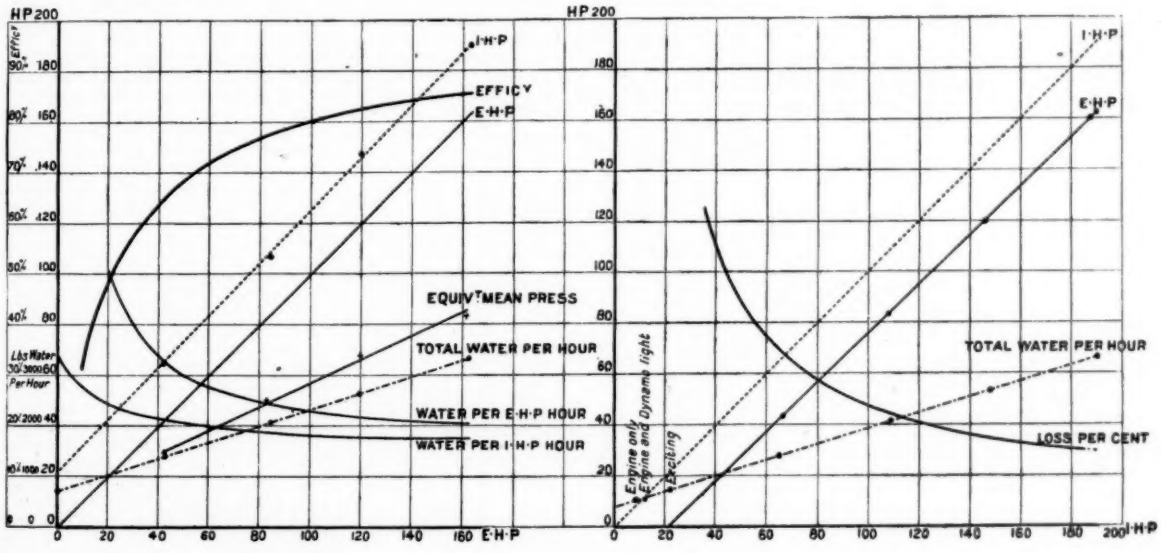


FIG. 1.

FIG. 2.

after having been condensed in a surface condenser. I believe this to be the most accurate method of steam determination which has as yet been practically carried out. As to the general behaviour of the dynamo, I can only say that it ran absolutely sparklessly throughout the whole of the trials, and gave no sign of any trouble whatever. Taking together the high efficiency of this set, its good results as to temperature and sparklessness, and its small consumption of steam per E.H.P., it takes its place with only three or four others quite at the head of the very large number which I have tested.

ALEX. B. W. KENNEDY.

19, Little Queen Street, Westminster,
May 24th, 1893.

ADDITIONAL FROM J. H. HOLMES & CO.

From cards furnished by Messrs. Willans & Robinson, taken when the engine was running disconnected from the armature, but at a slower speed, so as to get more accurate reading, they find the mean pressure (reduced to L.P.) to be 4·5 lbs. This cannot be far wrong for we have :—

External circuit		85·6 per cent.
Engine itself $\frac{4·5}{42·6}$		10·5
Dynamo excited or otherwise		4·0
Engine efficiency $\frac{42·6 - 4·5}{42·6}$		89·5 „
therefore		
Dynamo efficiency $\frac{85·6}{89·5}$ = ...		95·6 „

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

An ordinary general meeting of the institution was held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday evening, April 13th, Mr. W. H. Preece, F.R.S., president, in the chair, when a paper on "The Distribution of Power by Alternate-Current Motors," was read by Mr. Albion T. Snell, member.

DISCUSSION.

The PRESIDENT said the subject of alternate current motors was one of great interest at the present moment, and they were all looking forward to the introduction of an efficient alternating current motor. He hoped the discussion on the paper would lead to some novelty and some information.

Mr. KAPP said it would perhaps be well if he were at once to ask Mr. Snell about some things in the paper which seemed to be printer's errors. In one place, he said, when speaking of the two-current motor, that the common return must be of double section for the same loss. He (Mr. Kapp) fancied that must be an error. Mr. Snell must mean 41 per cent. more section, because the two currents were at 90 per cent. phase difference, and the two currents together could never be double the single current. Then, in one of the formulæ given the area of the iron of the armature was introduced; ought not that to be the number of turns of the wire?

Mr. SNELL: That is so.

Mr. KAPP, continuing, said towards the end the word armature was evidently used instead of field. The author said the most feasible windings on the armature were one with small self-induction, and the other with large self-induction. He was particularly anxious to point this out, because, as a matter of fact, Mr. Brown had made a motor with two fields.

Mr. SNELL: That should be field.

Mr. KAPP, proceeding to discuss the paper, first congratulated Mr. Snell for introducing it. English electrical engineers, he said, had been working with a cosine of lag that was really shocking. On the continent and in America they had gone ahead at a great rate, but we had absolutely not a single multiphase current motor in practical work in this country. They might say that was because they were of no use; as a matter of fact that was not the case. There was quite a number of them doing excellent work abroad. Only three months ago he received a newspaper from quite an out of the way place in Switzerland which was printed by means of motive power supplied from a *single-phase* * alternating current motor. There was no difficulty in a multiphase current motor which would serve as an excuse for having neglected the subject so long. He would like to make a criticism which applied very much to most of the theories which had hitherto been put forth to explain multiphase current working. Authors found it extremely convenient to neglect armature reaction. Now, to investigate scientifically the theory of rotary field motors, without considering armature reaction, was very much like the proverbial case of playing "Hamlet" without the principal character. Armature reaction was extremely important, and it had not so small an effect as the author seemed to suppose. Mr. Snell has given them, though not quite endorsing it with his authority, the explanation of Dobrowolski as to why his three-phase currents were much better than the two-phase currents, and why the complicated six-linked arrangement was better than the ordinary three-phase. Practical experience did not prove that at all. There was no disadvantage in the two-phase current. On paper, when they came to draw out those curves, it looked almost convincing; they saw those wavy lines going up and down and they said "It must be a very bad effect, having this pulsating field." But as a matter of fact they did not get that effect; it acted on an armature plentifully provided with good conductors, and the result of the presence of those conductors was that all the pulsations of the field were immediately wiped out. It was as though they had a transformer with a short-circuit secondary; when the secondary was short-circuited they could not get up any E.M.F., and that proved that they could not get up a pulsation of field; they could get up an E.M.F. which would burn out the transformer, but for a small pulsation they would not burn out the transformer. Any tendency to pulsation in the armature would immediately call forth opposite currents in the armature conductors, which would balance the pulsations, and so there would be very little waste of power. That was, he believed, the only objection which the advocates of three-phase currents had been able to raise against the ordinary two-phase current. But on the other hand the ordinary two-phase current had the enormous advantage of being easily regulated. The three-phase current had been introduced in Heilbron, Lauffen machines being used, and it worked admirably there; but the superintendent had a very heavy time of it before he was able to balance all his customers properly, so that all three branches were equally loaded. At last he succeeded, and everybody was satisfied, but none of those present would envy him his job. The author said that the maximum effort would be obtained with a current little greater than that required for the greatest output. As far as he understood the author's argument, it seemed that at the starting of the current, when the frequency of the armature current was a maximum, the torque should be greatest. As a matter of fact that was not so. The torque was very small, and was simply due to the usual field being almost completely wiped out by the armature.

Mr. SNELL: That is what I say.

Mr. KAPP said that was right then. In the diagram given he saw a very interesting curve, but he was not sure that he understood it. The curve shown represented the induction of the armature core This curve ran down very rapidly, and that would suggest that the particular dynamo had rather weak field magnets. He had never seen a characteristic curve which ran down so rapidly as that. He did not know whether the machine was specially made.

Mr. SNELL: The reason is simple. It is under excited. I had to balance it for the E.M.Fs. I wanted.

Mr. KAPP, continuing, said there was one more point he wished to draw attention to. The author said: "Mr. C. E. Brown has already suggested bedding the field as well as the armature turns in iron, and the same end may be attained by perhaps a better way, *i.e.*, by winding the field-coils in drum fashion." He (Mr. Kapp) failed to see how the particular way of winding could affect the magnetic resistance between the surface of the field and that of the armature. He would ask the author whether that was not an oversight.

Mr. SNELL thought they were talking at cross purposes, chiefly on account of the definition of field and armature. He had stated in the beginning of his paper that he regarded as the armature that part of the machine which had the induced currents in it, and the field that which received the Drehstrom current. He had made a slip in the particular case to which Mr. Kapp had referred.

The PRESIDENT said that from the list he had before him it was evident a good many members wished to take part in the discussion, and no doubt they would be very glad to have the opportunity of clearing away a little of the fog that might have entered into their minds in consequence of the discrepancies in the paper. He knew that the novel motor of Mr. Brown that had been referred to was in London, and he thought Mr. Sparkes would be kind enough to bring it before them at the next meeting, when they might be able to see it in action. He would therefore adjourn the discussion for a fortnight.

* Speaker said "single" phase, but appears to have meant "multiphase."

An ordinary general meeting of the Institution was held on Thursday evening, April 27th, Mr. Alexander Siemens, Vice-President, in the chair.

After the transaction of the usual formal business, the discussion on Mr. Snell's paper on "The Distribution of Power by Alternate Current Motors," was resumed.

Mr. SPARKS brought before the meeting two motors designed by Mr. C. E. L. Brown, each being of 1 H.P. The larger one was of the synchronous type, and the smaller one of the non-synchronous type, both being single-phase motors. The synchronous motor, although comparatively well-known, was not described in Mr. Snell's paper. This motor had no great torque at starting, so had to be started when the belt was on the loose pulley. As a matter of fact the motor had to be placed in such a position that the brushes made contact, each one with a segment, then the motor would start on the loose pulley. Otherwise, if the motor had brushes touching on two sections, they would have to move the pulley or pull the belt so that the brushes touched on two independent segments. Unless the motor was put in the right position, of course there would be some trouble in starting it. As a matter of fact, however, it was very easily started indeed, and he believed everybody who had tried had been able to do it. The field magnets consisted of four poles, each one with a coil on it, the coils being two in parallel and supplying the current through the commutator. The armature stamping had four coils connected in series, and these coils were wound into perforations which surrounded the field. The E.M.F. of the synchronous motor working was 92 at a periodicity of 40; there were a few, but he did not know of many installations in this country working at so low a periodicity as that. On starting the motor the armature and field magnets were placed in parallel across the E.M.F. of 92 volts, and a fixed resistance was put in series in the field. The field magnet was supposed to be central in the armature, and the air-gap was very small. On starting up a choking coil was put in. The field-magnet, in series with the commutator, had a fixed resistance on starting in series with it, and it was put in parallel with the armature. If the motor was in such a position that if they took the sections of the commutator with brushes on two opposite points, the motor would start when on the loose pulley. It went away directly at a fair speed until it reached a certain definite speed, without any further tendency to increase, when part of the choking coil should be cut out. Then it went faster, and another section of the choking coil must be cut out, until the motor attained a speed of 90 per cent., or perhaps not quite so much, of its synchronous speed. The motor then began to make a kind of beat, but that was not very important. The field-magnet should now be cut out altogether, and at the same time the field-magnet should be connected across a few turns of the armature, so that as soon as the motor was running at a synchronous speed the connections were as indicated. Directly the resistance was cut out, supposing the motor were running at from 80 to 90 per cent. of its synchronous speed, it, as it were, galloped up and got into synchronism in a very remarkable manner. As soon as it attained synchronous speed the belt should be transferred from the loose pulley to the tight one. Then the motor could have the load thrown on it suddenly, not only its nominal load, but they could put on, say, three times its rated load without in any way dragging it out of synchronism, and, as the motor had a very wide neutral point, they never required to shift the brushes. That type of motor had been very largely used, and, he believed, had given satisfaction, although it was unknown in England. The motor ran very quietly, and, of course, it was very easy to balance, and, having the ring oiling arrangement, it required practically no attention. It ran at a speed of 1,200 revolutions at a periodicity of 40. That motor had been used for several weeks to drive part of the factory in Charterhouse Square, and that type of motor was used up to a size of 10 H.P. The second motor was one which should be of great interest to that institution. It was of the non-synchronous type and worked at 40 periods at 120 volts. Its armature consisted of a number of stampings, and these all had holes through them, and through each hole was a carefully insulated copper rod. The whole of these were

connected up at both ends, so that they really had a number of short circuited coils. There were no brushes of any kind to this motor, and the field-magnet winding was similar to the armature winding of the synchronous motor; but there were two sets of four coils each. One set of coils was always in use when the motor was in work, and the second was only in use when the motor was starting. The two series of coils were so placed that one set overlapped the other; that was to say, the winding of one coil came in the centre of the other. The E.M.F. required was 120 volts for the normal output of 1 B.H.P. In order to start this motor the current was switched straight on to the field poles, which were connected in parallel. There was a switch, which was closed on starting, and the one set of coils was connected in series with a condenser of extremely simple construction, consisting of a series of iron stampings separated by wooden blocks, the intervening space being filled up with a 10 per cent. solution of caustic soda. With a torque corresponding to a torque of 3 H.P. at full load, the speed ran up practically to that of synchronism, although it was practically a non-synchronous motor. The motor, when loaded to 1 brake H.P., took 11 ampères at 1,200 volts, or 1,320 apparent watts. When giving, during short periods, 2 H.P. it took 1,760 apparent watts, or gave a return in brake H.P., in the case where it was overloaded, of 54 per cent. of the apparent watts put into the motor; when giving 1 brake H.P. the return was 66 per cent. of the apparent watts. With a 10 H.P. motor of this type, weighing between 9 and 10 cwt., which was daily working in a saw mill, giving over 15 brake H.P., the commercial efficiency of the normal brake H.P. was between 88 and 90 per cent. of the real watts supplied to it, the difference between the real and the apparent watts being 12 per cent. When taking the maximum power from that motor the percentage drop in speed value, that of synchronism, was a little over 3—3·2 per cent., as a matter of fact; so it was practically a constant speed, although non-synchronous. He would put before them a comparison of a three-phase apparatus the particulars of which were published by Dobrowolski in the *Electrotechnische Zeitschrift* of March 31st last, and a 1 H.P. single-phase motor tested by Messrs. Brown, and if not the actual motor before them, it was a fellow one to it:—

	Three-phase motor.	Single-phase.
Nominal output	1 B.H.P.	1 B.H.P.
Tension	104 volts.	120 volts.
Current (no load)	7·8 amèpres.	6 ampères.
Current (full load)	13·85 ampères.	11 ampères.
Apparent watts	1,440	1,320
Frequency	50	42
Speed (no load)	1,490	1,250
Speed (full load)	1,375	1,210
Per cent. drop of speed ...	7·22	3·2
Weight of motor	207 lbs.	141 lbs.
Temperature rise	40—50° C.	25—30° C.

Motors of that type were running, or shortly would be running, at Barden, Lucerne, Cologne, Dresden, Rome, and other places, and he thought Mr. Brown was to be congratulated on the very remarkable results he had obtained. The special points of the motor were the great advantage of the total absence of the collector-commutator; the ring form of oiling; the ease of mechanical construction up to large H.Ps.; and the minimum attention and repairs required.

Mr. SWINBURNE did not know that it was of much use working out a motor for a frequency of 40 in this country; they must start with 100, and if they wanted to develop largely, they must have it up to 133 for America. There was a great difference between a frequency of 40 and one of 133, as anyone who had experimented largely with motors would know. The chief difficulty with motors had been, not the difficulty of starting, though that, of course, was a serious one, but the difficulty of getting them to run without taking a fairly large current with no load. These motors took 7·8 ampères with no load and 13·85 ampères with full load. It must be remembered that that had to come through the transformer, and it had also to come through the meter, and it would be a difficult thing to place a motor that took half current at no load. It was a serious matter, indeed, as soon as they began to try to put it into practice in a place like England. It might be very well in some places, in Switzerland, perhaps, where there was water power, and the installation was chiefly a motor installation; but he did not think, unless an alternating motor would run under nearly the same conditions as a direct current motor, that it was of much use putting it on the market in this country. He did not think they could consider the alternating motor problem solved, and they never would solve it until they made a machine which was self-exciting, not excited by the reactions of one of the parts on the other. All those motors, when examined carefully, would be found to be machines which had non-exciting field-magnets entirely excited by their own armature reactions—he meant they had no field windings on them. That was an evil. When they had field windings on those machines they would reduce the no load current.

Mr. W. M. MORDEY thought that, whatever developments might take place in alternating current power transmission, it would be found that for large powers synchronous motors would have advantages. As to the objection that motors must be designed not only with reference to the pressure, but also with regard to the frequency of the current, he did not think that was a very great difficulty. There was a further objection stated, that alternating current synchronous motors had dead points in each period of the alternation. That was true; but the dead points were very little ones. There were two in a section as a rule, but there was no trouble in that connection. The fact that machines had dead points had not been found an insuperable objection in the case of steam engines, and he did not see why it should in the case of synchronous motors. He agreed with Mr. Swinburne that until motors were produced that could be run on the ordinary alternating current mains, the same mains as were used for lighting, motors would be very little used except for special cases. He thought the difficulty with regard to the periodicity was a temporary one. They had had two or three-phase motors as a make-shift; now they were getting single-phase motors that would run up to 40 or 50 periods, and in a little while they would have motors that would run at 100 or 133 periods. The demand for alternating motors was one they were constantly coming across, but they were not coming across it, he was afraid, because of any real demand for motors, but for what might be called electioneering reasons; unscrupulous commercial gentlemen were pushing their wares and attempting to introduce low tension and direct current working in cases where alternating current and high tension were obviously preferable, bringing up the objection that motors were not used on alternate current circuits. It was of very little use to point out that not one per cent. of the output was for motors even in the cases where motors could be most freely used and without any difficulty whatever. He believed if they had alternating currents as good as the direct current motors of the present there would on ordinary installations be no use for them that would be to any extent important. The whole question turned—as Mr. Snell had suggested, though not very pointedly—on the question of periodicity. There was a disposition to go down to 40 or 50 periods a second instead of the 80, 90, 100 or 130 that was being used generally. He (Mr. Mordey) also thought, when you got down to 20 or 30 or even 40 periods a second you might just as well have a direct current, because the disadvantages of alternating currents at low periods were so great that really very little could be said for them in comparison with direct current working. One of the principal reasons why 40 periods had been so largely used on the Continent was owing to the difficulty of designing machines of certain types to work at a greater rate. The Ganz motors had been very largely used, and those as well as others were worked at 40 periods simply because they were machines having a lot of iron in them and there were a good many electrical and structural difficulties if any attempt were made to use them at higher rates. In alternating current distribution the key to commercially good results had been found in the transformer. To make transformers equally good and equally efficient at 40 or 50 periods as at 100 was very difficult, and it became then very costly; in fact he doubted whether anything like the same results could, at any expenditure, be got at 40 as at 100 periods. The transformers were not only costly, they were wasteful. It was not, as he had been told it was, a question of design; he had been told that a 100 period transformer must not be used at 40, or a 40 at 100 periods, but that a transformer must be properly designed, more iron should be put in in the one case, and so on. Well, he had taken 40 period transformers made by the most experienced makers, and had run them at 100 periods at the ordinary E.M.F., and he had found, although they had been specially designed to run at 40 periods, they were very much more efficient, much cooler, and altogether better things at 100 periods than at 40. He had then taken 100 period transformers and run them on 40 period mains, and burnt them up. That, he thought, showed there was no basis of truth in the argument that you could design a transformer equally well for any period.

Prof. AYRTON: As to the question of motors affecting the choice of the direct current, he certainly agreed that in this country at the present time it ought not to affect the choice at all. As a matter of fact, motors were so little used that it was of very little consequence indeed whether or not an alternating current was less or more efficient than a direct current motor. In advising a town a little while ago to use alternating currents, he told them it was not worth considering whether there was any difficulty about the motor, and if anybody wanted to use the alternating current for a motor, it would pay them to supply power at 1d. or 2d. per unit for the purpose. The advantages of using transformers for the distribution of electric lighting in a scattered town were so great that the small disadvantage of the inefficiency of alternate current motors was not really worth considering. Mr. Kapp had pointed out at the previous meeting one reason why the theoretical variations in the magnetisation of the field of a Drehstrom motor were not so great, why the theoretical considerations made the variations greater than they really were; he pointed out that one cause was the re-action of the armature. Another cause was that those calculations applied merely to the variation in the exciting currents. They knew, of course, that when iron was more or less magnetised, the induction did not fall nearly as rapidly as the current. In speaking of the series or open circuit, Mr. Snell said the potential difference at the terminals of the coil lagged 30° behind the potential difference between the mains. That was a mistake. It should be that the potential difference at the terminals of a coil with series winding was 30° in advance of the potential difference between the mains. Then the author said "it was shown that with combined three-phase currents, even when neglecting the self-induction of the coils, there is a constant phase difference between the current and the line pressure. This, although not in itself a direct loss, is the cause of great difficulty in measuring, regulating, and controlling the currents, and also reduces the output for a given weight of material." He seemed to say that because there was a phase difference between the current and the line pressure this reduced the output for a given weight of material. That reasoning seemed to him to be defective. The difference of phase he was speaking of was not a difference of phase between the current in a wire and the potential difference of that wire, but the difference of phase between the current in one wire and the potential difference in another wire. Or to put it more simply, in this three-phase system if there was no self-induction there was no difference of phase anywhere between the current in the wire and the potential difference which was producing the current in that wire, so that that reasoning fell to the ground. Beyond that, it was not true that the output for a given weight of material was less in the three-phase system, assuming no self-induction, than with the two-phase, as was pointed out some years by Dobrowolski. In the three-phase system of distribution they had three wires on their poles, each wire carying a certain maximum current, the insulation being

such as to allow of a certain maximum potential difference between the mains. The cost of putting up the wires was increased 50 per cent., as there was one more wire, but the output was increased by 73 per cent. over the two wires and single-phase distribution of motive power. So that, in fact, so far from there being less output obtainable for a given weight of material on the three-wire system there was actually a greater output. When Mr. Snell was making experiments with a Gramme machine used as a three-phase dynamo, he said: "It will also be seen that the direct pressure is higher than that of the alternating in the proportion of 158 to 94 on open circuit." What was of interest there was to see how nearly those numbers would be given by the sine law of variation of E.M.F. and the position of a coil in a Gramme machine. If they imagined that the E.M.F. in the coil in a Gramme machine was 0 when it touched the brushes, and was at its maximum value when it was in the line of right angles, and imagined the E.M.F. as the sine of the angle, they could work out then what would be the potential difference at the terminals of the rotating armature when they took any two points on the armature. They could work out the E.M.F. they would get taking off the current at any two points of the armature, and could compare that with the E.M.F. or potential difference they got from the stationary brushes, which gave, of course, the direct potential difference. He had worked it out, and found that they would not get the result which Mr. Snell gave if the sine law were true. He did not want to imply that the result was wrong; on the contrary, it showed that in a Gramme machine the sine law was not true. His students had confirmed that result in another way. When making experiments some time ago on a somewhat similar Gramme machine, from different points of the armature of which wires were taken to rings, and by making experiments in somewhat the same sort of way, they had proved that the relationship between the mean potential difference and the maximum potential difference, which they knew had a fixed ratio, if they assumed that the alternating current obeyed the sine law, was a simple one; they showed how that ratio varied when the current varied, and how the character of the outside circuit was varied. The numbers given by Mr. Snell confirmed the results they arrived at and showed that in an ordinary Gramme machine the sine law, which was so charming to mathematicians for the purposes of calculation, and which had only one defect that he knew of, which was that it did not exist in practice, did not in this, as in many other cases, have any existence. It would be very valuable if Mr. Snell could repeat some of the experiments he had made, measuring not merely the current and potential difference, the apparent watts, but the true watts also.

Mr. SNELL said there were one or two points to which he would like to reply at once. Mr. Sparks had put before them a very interesting motor, to which he had referred in his paper, doing it, he thought, full justice as it stood. He could not quite agree with Mr. Sparks that so much credit was due to Mr. Brown; the motor was, after all, as Mr. Swinburne had said, nothing but the development of Elihu Thomson's motor. With regard to the non-synchronous motor, that had, undoubtedly advanced the subject very materially. But, as he had said in the concluding sentence of his paper, "This is, perhaps, the best type of single-phase motor up to date; but it is undoubtedly susceptible of considerable improvement, and the problem of alternate current motors suitable for running on ordinary supply circuits cannot yet be said to be satisfactorily solved." He thought the majority of the speakers bore him out on that point. As to the question of period, he had said that the crux was the frequency. Undoubtedly until they could make a single-phase motor that would work on a circuit of 100 cycles per second, they had not solved the problem. At the time he wrote the paper he was thinking a great deal about motors for use in coal pits; there, the question was not so much a motor that would work with high efficiency as a motor that would work without sparking, and the little motor shown on the table realised that condition. If the efficiency of that motor was only 60 per cent., it would do for a great many purposes in a coal pit, and if a larger motor could be built with an efficiency of from 70 to 80 per cent., they might be said to have advanced the question of the application of power to mine working very materially. Lighting in a coal-pit was of secondary importance altogether; if the lamps fluctuated a little, it would be of secondary importance to the distribution of power for driving the machines. He would like to say a few words about the definition of field and armature. He had taken the definition which he believed was the Continental one; that was, he called the armature that part which had the currents induced in it, and the field, that part which had the current supplied to it, and so caused the excitement in the field. That being the case, he called the stationary part of Mr. Brown's motor the field, that part which had four fixed coils, and he called that part the field because the current which excited the machine was put through it. He called that part which revolved, the armature, because it had currents induced in it by virtue of those currents. The converse was also easily seen.

The CHAIRMAN called on the meeting to give Mr. Snell its best thanks for his interesting paper, and in doing so said he could not help emphasising one point which had been brought out, which was that English engineers should not be too much blamed for holding back on this question of alternating currents. They were, after all, a body of practical people who had to apply science to everyday life, and that which had, to a great extent, to govern them in what they did and what they investigated was the eternal question of £ s. d. His firm had been very much interested in rotary motors and had worked a good deal in that direction. They had not done so much in England because it was obviously unnecessary to go into an extra set of experiments whilst they had the experience of Berlin at their disposal. Whenever they had to work out a problem for transmitting power to a distance they gave the exact problem to their Berlin house and asked them to work it out according to the rotary system, and, up to the present, they had not had one instance in which they could not carry out such a problem just as well either by direct currents or by the ordinary alternating current machines as they could have done by the rotary currents. It was certainly the truth, as had been brought out that night, that rotary current motors were but a step. They must wait until they had got a thoroughly practical alternate-current motor which they could use on the ordinary mains, and then they would use it.

The meeting then adjourned.

NEW PATENTS—1893.

10,474. "Improvements in the construction and form of accumulators for the storage of electrical energy." J. S. BOLTON and T. J. MURDAY. Dated May 29th.

10,501. "Improved method of heating liquids by electricity." C. H. PRICHARD. Dated May 29th. (*Complete.*)

10,533. "Improvements in electrical signalling and printing telegraph systems, and in apparatus employed therein." J. Y. JOHNSON. (Communicated by A. S. McCaskey, United States.) Dated May 30th. (*Complete.*)

10,569. "Improvements in means or apparatus for regulating the temperature of electrical heating, cooking, or like apparatus." R. E. B. CROMPTON and H. J. DOWSING. Dated May 30th.

10,584. "Improvements in connection with electrolytic apparatus." H. Y. CASTNER. Dated May 30th.

10,594. "A novel method of ornamenting or decorating the bulbs of incandescent electric lamps." T. B. BROWNE. Dated May 30th.

10,597. "Improvements in devices for adapting electric lamps to ordinary candle fittings and the like." G. S. SLUCE. Dated May 30th.

10,615. "Improvements in telephony, or means for transmitting telephonic signals through long distances." J. HINES. Dated May 30th.

10,623. "Improvements in printing telegraphs." D. MURRAY. Dated May 30th.

10,630. "An improved material, or combination of materials, to be used for the manufacture of electric arc candles, applicable also for the manufacture of brushes or collectors of dynamos or electric motors." T. ODDY. Dated May 30th.

10,648. "An improved combined electric light and heat stove." G. MITCHELL. Dated May 31st.

10,696. "Improvements in insulators for electric wires." H. H. LAKE. (Communicated by E. Hartmann and W. Braun, Germany.) Dated May 31st.

10,720. "Driving tricycles and other similar vehicles by electricity." A. MATUSZKIEWICZ. Dated June 1st.

10,765. "Improvements in secondary voltaic batteries." E. J. CLUBBE and A. W. SOUTHEY. Dated June 1st.

10,772. "Improvements in ceiling roses for electric connections." G. H. CUTTING. Dated June 1st.

10,788. "Improvements in the arrangement of stations for the generation of electricity." The Hon. C. A. PARSONS. Dated June 2nd.

10,821. "Improvements in or relating to the regulation of electric currents." W. S. BOULT, C. R. BOULT, and F. G. BAILY. Dated June 2nd.

10,830. "Improvements in electric storage batteries." E. BAILEY and G. M. GORDON. Dated June 2nd.

10,843. "Improvements in or connected with electric railways and tramways." J. CLARET and O. WUILLEUMIER. Dated June 2nd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

17,706. "An improved form of voltmeter." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated October 16th. Is on the principle of a potentiometer working automatically. The volts to be measured are applied to the ends of a resistance; and a standard cell in series with a relay of any convenient form is applied to a part of it. When the drop of the volts over this part to the ends of which the cell and relay are applied is equal and opposite to that of the standard cell, no current passes through the relay, but when this drop is less than the electromotive force of the standard, a current passes and the relay tongue or its equivalent makes contact with one stop; and *vice versa* when the drop is greater than the electromotive force of the standard cell with the other stop. These contacts set in motion, or cause to set in motion, or to act, suitable motive power by which either the total resistance is altered or the points on the resistance, to which the cell and relay circuit is applied are varied in such a way that the drop of volts over the latter portion is increased or diminished to its former value. At the same time the motive power works a pointer backward or forward according to the changes made in the resistances, and by suitably marking a dial this pointer may be made to indicate the volts at the terminals of the resistance, and if desired a continuous record of them may be obtained on a paper on a moving drum or other equivalent means. 3 claims.

17,836. "Improvements in and relating to electric meters." R. N. LUCAS. Dated October 19th. The inventor makes use of the principle that from a cone revolved by clockwork or other suitable means, and mounted so as to be capable of revolution about its axis, motion may be communicated to another cone similarly mounted and arranged with its apex adjacent to the base of the first cone, by means of a disc band wheel or other suitable appliance or combination of such appliances, and that in this way the velocity of the second cone can within certain limits be made to assume any desired relation to that of the first cone. 5 claims.

18,436. "Improved apparatus for measuring and recording electric currents." W. THOMSON. Dated October 27th. For measuring electric currents the inventor uses a steel magnet, straight or of horseshoe shape, with one end or both ends attracted by a fixed solenoid, or two fixed solenoids, in the manner described in specification No. 4,617, A.D. 1883. Or instead of the steel magnet he uses an electro-magnet consisting of a thin bar of soft iron with a solenoid of fine insulated wire wound upon it. The two ends of this wire are connected with fixed conductors by two fine elastic wires which may be in the shape of spiral springs, and may be used for bearing the weight of the electro-magnet. The current to be measured passes through a fixed solenoid, or two fixed solenoids, attracting inwards one end or both ends of the movable electro-magnet. 5 claims.

18,477. "A depolarising liquid for galvanic batteries." O. SCHLESINGER. Dated October 27th. Consists in a depolarising liquid for two liquid galvanic batteries. The liquid is composed mainly of a sulphuric acid solution, trioxyde of chromium and nitrous acid. 2 claims.

21,143. "Improvements in electrical cut-outs." W. P. ADAMS. Dated December 4th. Consists in so arranging the contacts of the cut-out that the fuse wire may be easily replaced without a screw-driver or other tool. This is accomplished by using spring contact pieces. 1 claim.

21,250. "Improvements in phonographs." S. FRANK and L. ROSENTHAL. Dated December 5th. Consists in actuating the phonogram disc by a friction wheel which preserves a constant position in relation to the stylus whilst it actuates the phonogram disc at a gradually variable radius corresponding to that of the stylus, so that the angular velocity of the disc is diminished exactly in proportion as the point at which the stylus acts recedes from the centre of the disc, thereby producing a record from which an accurate and uniform reproduction of the sounds may be obtained. 7 claims.

21,369. "Improvements in switches for primary or secondary batteries." H. H. LAKE. (Communicated from abroad by H. Müller, of Nuremberg.) Dated December 7th. In connection with such switches by which a resistance prevents the short-circuiting of single cells, a special contact breaking apparatus is applied, which immediately before the sliding contact leaves the contact piece of the cell, either opens the circuit of the cell closed by the resistance, or switches in this resistance, so that the generation of sparks does not take place at the switch, but at the special contact breaking apparatus. The necessary motion is given to this apparatus by the sliding contact, either in a mechanical or an electro-mechanical manner. 2 claims.

21,720. "Improvements in switches for regulating currents of electricity." J. C. HOWELL and P. E. POWNALL. Dated December 11th. A worm and wormwheel are so arranged, that one turn of the hand wheel will move the main contact arm from the centre of one to the centre of the next of the fixed contacts. There is also a crank or an eccentric on the worm shaft which, by means of a connecting rod, imparts a reciprocating motion to a spindle which is guided by two guide brackets. This spindle imparts an oscillating motion to a lever which is pivoted near its centre. At one end of this lever is fixed a die through which the spindle passes. Fixed on the spindle are two collars, one on each side of the die and between which and the die, springs are interposed to relieve shocks. At the other end of the oscillating lever one or more contact or sparking pieces are arranged, which make electrical connection, with an equal number of fixed contact or sparking pieces. 4 claims.

21,923. "An improved electrical apparatus for driving clockwork." F. H. BERRY. Dated December 15th. On the central arbor of the clockwork the inventor loosely mounts a lever which is engaged with a ratchet wheel by a hooked pawl, and one arm of this lever is so weighted as to be capable of actuating the clockwork through the ratchet wheel, while the other arm is connected to the armature of an electro-magnet, mounted in the proper position in respect of the clockwork. Near the clockwork is mounted another lever, one arm of which lever also is weighted, and on the under side of the other arm, which is in the path of the weighted arm of the actuating lever, is a contact point preferably V-shaped, and in a proper corresponding position below is a contact post preferably formed by two parallel springs between which the V-shaped point can enter, and near these springs is fitted a permanent magnet. The one terminal of this apparatus is electrically connected with this latter weighted lever, and the other terminal with the electro-magnet, and therethrough with the two springs or other contact post, and with or in connection with these two terminals is fitted any suitable battery or other source of electricity. Therefore when, and as, the weighted arm of the actuating lever descends while it is driving the clockwork at the arranged for position it comes in contact with the free arm of the other lever, and depresses the same against the weight on the other arm thereof until the contact point on its under side touches the contact post, being there held by the permanent magnet, and the circuit is completed. The current, therefore, passes from this lever and through the contact post to and through the electro-magnet, whereby the armature is drawn down and thus raises the weighted arm of the actuating lever into its uppermost position in readiness again to actuate the clockwork in and by its descent. When the weighted arm of the actuating lever is lifted off the free arm of the other lever, this latter arm is by the counterbalancing weight lifted off the contact post whereby the circuit is broken, and thus all parts of this apparatus are in position to recommence, or practically to continue, their aforesaid course of action as is desired. 3 claims.

22,027. "Improvements in galleries, holders, or supports for the globes or shades for electric lights and gas lamps, also applicable to holders for incandescent lamps." V. SILBERBERG. Dated December 16th. The inventor provides three hinged arms, attached by any convenient means, either for incandescent lamps directly to the bracket, arm fitting or the holder, or to a sleeve screwed upon these latter. One end of each arm is suitably bent so as to engage with the flange of the shade, or a corresponding part of the globe or lamp. The other end of each arm forms a cam, upon which acts a nut provided on the fitting or bracket, or on the sleeve carrying the arms. When this invention is to be used, the nut (which may have wings like a thumb nut) is screwed up or down on the fitting or sleeve, and allow the hinged arms to open out or to contract as required. 2 claims.

22,145. "Improved jar or cell for galvanic batteries." W. P. THOMPSON. (A communication by O. Hirsch, of Germany.) Dated December 18th. The battery jar or cell consists of glass, is square in form, and has at its upper edge the usual form of a glass battery. In the corner destined for receiving the zinc plate, impressions or projections are formed at the time of blowing of the glass in the mould. The projections or impressions are applied on the sides at a suitable distance from the corner, so that the zinc bar may have space for free play in the space enclosed by these projections. 1 claim.

CORRESPONDENCE.

The British Workman and Electric Cooking.

I wish to say at the outset that though I have worked at anything and everything from my youth upwards, and still work my 12 and 16 hours per diem, I am not, in the conventional sense, a British workman, nor am I specially in love with him as a class. Perhaps this is because it is not my privilege to charge as overtime for snoozing in a railway carriage, or squatting upon my blunter end within coo-ee of the job upon which I am paid to expend my energies, which same squatting the British workman considers sufficiently represents work to warrant same being charged as time; for does it not confine him within a short radius of the scene of his labours, and so shut him off from the intelligent enjoyment of his fit and proper corner in that building which is usually designated as P.H. in the maps of H.M. Ordnance Survey, such intelligent enjoyment being at his own charge? When, however, the Institute of Civil Engineers is treated to a special lecture upon the follies and shortcomings of the working man, it is well to remember that each and every reference made at the meetings of the Institute to the folly of the B.W., who is not content to simply accept sufficient pay to keep him alive and efficient as a money-earner for his employer, and to ask no more, is cheered to the echo, the younger members joining in, many of whom are probably fated not to earn even workman's wages, though they do not, of course, mean to cheer the application of such sound doctrine to themselves.

Now, it chanced some little time ago that a matter of business required my attendance at a little country village some seven miles from a station, and I thought fit to call at a wayside P.H. to enquire for a conveyance. There was one for hire kept there, and Boniface himself became my Jehu. I soon found he had in his earlier days worked at the bench, and come out, finally, as foreman in several good shops, and, being a Yorkshireman, he had a fair share of mother wit. He informed me that at one place where he had worked, the employer came to him and complained of the bad state of trade. He attributed this to over production, and said that they would have to go back to the 10 hours' system. The existing state of affairs was of course that of the 9 hours' day. My Jehu laughed at the idea, and he must indeed be a dull fool who could not detect some amount of incongruity in the attempt to cure over production by a return to longer hours. This showed the intelligence of the employer.

Now I do not wish to discuss the question of the application of Carnot's function to the constitution of society. Doubtless the doctrine is very comforting to the T_1 element of the community, who ought, however, to remember that undue striving to raise T_1 to its higher limits is liable to be attended with explosive results, whilst to keep T_2 to a low

point is not only a matter of great difficulty below a certain limit, but attended with great risk of lowering the initial T_1 without adequately increasing the vacuum. It may also not be amiss to remind Dr. Anderson that the absolute values of T_1 and T_2 in the more practical examples do not vary far from a ratio of 4 : 3. Is Dr. Anderson prepared to allow the day labourer to earn £75 for each £100 earned by a Westminster magnate or a Q.C., because this is what his Carnot theory would imply, and he may be well assured that the human T_2 would not even object to the T_1 element being rated even as the furnace temperature ratio itself, for this would mean infinitely more to poor T_2 than the existing regime.

He who sups with the Devil requires verily a long spoon. Analogies are dangerous tools and double edged. Those among us who happen by luck to find ourselves among the initial steam in place of at the dead level of the condensing pond, or blown off with the mud, do not need to remind weaker brethren of their perhaps undeserved calamity. I have followed Carnot's cycle from a T_1 as high as that of the able lecturer himself to a very low degree of T_2 indeed, and though I am pleased to say that I have found the cycle reversible to a considerable distance back to T_1, I regret to say that there are intellects as bright at the lower point as at the upper, and that social position is meted out rather to the financial ability, which is more possessed by the ignorant than the learned.

What does Mr. Dowsing mean by cooking in a pure atmosphere? By a pure atmosphere he seems to imply one suited for the breath of man. Now, whatever may be the atmosphere produced by the burning of coal gas, it is a fact that food cooked in an oven, inside which is a ring of plain gas burners—not even Bunsen's—is superior, or, at least, fully equal to the same cooked in plain atmospheric air. The joint in such a gas oven was surrounded by the products of combustion, the only necessary precaution being that it should not touch the flame. I make this statement from an experience covering over 10 years. May it not be inferred that an atmosphere of carbonic acid gas, without oxydising influence, is really superior to one of oxygen, which Mr. Dowsing thinks should surround a cooking joint?

Cooking by electricity will need to justify itself by its price and convenience, not by any extraneous supposed advantages.

An oil stove will cook for a family for one shilling per week, more or less, according to family's means and inclinations. What will electricity do?

T.

The Voysey and Hosack Road-Breaker.

In speaking of our macadam road scarifier, you state quite correctly that it can be of little use in cutting trenches. It was never intended for this purpose, and is a perfectly separate invention, intended only for use in the repair of macadam roads. The trench-cutting machine was tried in Liverpool with great success, but has temporarily been put aside to allow us to complete the more useful and more difficult task of making a thoroughly good road scarifier. We hope before long to give contractors for underground works a good trench-cutting machine. In places where electrical power is available, it might be used to drive the machine.

A. W. Voysey.

A Curious Transformer Experiment.

The problem stated by Mr. Rankin Kennedy, under the above heading, in your current number, appears to me to be capable of very easy solution.

When the U-shaped plates are massed together, the average length through air of the lines of force thrown out from all parts of the coil, and passing through the iron plates, is much greater than when the plates are evenly disposed along the coil. Naturally, therefore, the part of the primary coil covered by the plates not being nearly sufficient to cause magnetic saturation of the iron, the total induction is greater in the latter case than in the former.

If this is the true explanation, Mr. Kennedy is at fault in assuming that "by this experiment it is found that parting the iron inside of the coils" (of a transformer) "also increases the induction through them."

W. S. Boult.

[Mr. Mordey suggests to us the following explanation of this experiment:—When the plates are apart the surface of iron exposed to the air (the polar surface) is large, and the cross-section of the air-gap is greatest. When the plates are pressed together the polar surface is decreased, and with a given magnetising force the magnetisation is reduced, the lamp in the secondary being dimmed. If the lamp were placed in the primary instead of the secondary, it would increase in brightness instead of decreasing. The iron, if free to move, tends to place itself so that the magnetisation is a maximum. The effect would not occur with the plates of a closed magnet transformer.—EDS. ELEC. REV.]

Relative Safety or Danger of Electric Light Current.

We should be glad to make a slight addendum to our letter of last week. 1. The name of the alternating current transformer we referred to is the *Woakes*, not Weeks as it appeared. 2. We have just been informed by Messrs. Woodhouse and Rawson United, Limited, that they "have supplied many magnetic cut-outs for alternating currents. The only difference in them is that we laminate the iron core to prevent heating, and calibrate them specially to suit the periodicity of the circuit." We hope soon to be able to test the suitability of these cut-outs for medical work.

The Electro-Medical Apparatus Company,
LAWRENCE AND KIRK, *Managers.*

What is an Alternation?

We must apologise for troubling you with such an elementary question, but it is a matter of surprise to us that two such authorities should give directly opposite opinions upon a point about which there ought to be no doubt. But "when doctors disagree, who shall decide?"

On page 639 of his "Dynamo-Electric Machinery," Prof. S. P. Thompson says, "The time taken for one complete alternation to and fro of the current is called one period." While Prof. Ayrton, in the discussion following Mr. Albion T. Snell's paper (*Journal*, No. 106, page 337), says, "Of course, in one period, there are two alternations."

Clearly one must be wrong. Which is it?

A Puzzled Trio.

Electric Cooking and Heating.

With your permission we will reply, briefly, to the letter in your last week's issue, signed, "The Writer of the Article."

Your correspondent appears to imagine that we claim to have discovered that an incandescent lamp can be used for heating purposes. What we do claim is the practical apparatus we have patented, and we may mention that we are not going to exploit this ourselves at all, as the Edison and Swan United Company have acquired the sole right to manufacture and sell under license. We will say no more about it here, but confine ourselves to replying on the scientific points on which your correspondent considers himself qualified to correct us, although his letter certainly gives no evidence of his ability. Without any relevancy that we can see, he mentions that only 2½ or 3 per cent. of the watt energy is utilised as light in an incandescent lamp, but he does not even allude to the radiant heat rays. Although we willingly admit that there are a few things about vacua that we would gladly know more about, we are not likely to learn that any measurable amount of energy is absorbed by the passage of radiant heat and light rays through a vacuum or a narrow air space. We are, therefore, able, if we think it advantageous commercially, to obtain a high efficiency without upsetting any of Nature's laws, although we may upset your correspondent's theories.

Miller and Woods.
Per L. M.

ELECTROLYTIC CHLORINE AND SODA.—We have received from Mr. James C. Richardson, of Snodland, a letter on this subject, in reply to that of Mr. Andreoli, which appeared in our last issue; but Mr. Richardson's letter is so insultingly worded, that we decline to publish it.—EDS. ELEC. REV.